

REGULATIONS
GOVERNING
COAL-LAND LEASES IN THE
TERRITORY OF ALASKA

APPROVED MAY 18, 1916

WITH
INFORMATION REGARDING COAL LANDS



WASHINGTON
GOVERNMENT PRINTING OFFICE
1916

6037

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REGULATIONS GOVERNING COAL-LAND LEASIES IN THE TERRITORY OF ALASKA.

LEASING OFFER.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., May 18, 1916.

In pursuance of the authority vested in the Secretary of the Interior by the act of Congress approved October 20, 1914 (38 Stat., 741), "to provide for the leasing of coal lands in the Territory of Alaska," the coal lands in the Matanuska and Bering River fields are now and hereby offered for leasing under the terms of said act and the regulations adopted and approved in accordance therewith.

Intending lessees will find herewith:

1. Copy of the law and regulations, with approved form of proposed lease.

2. Information relating to the operation and development of the Alaska coal fields, prepared in the several bureaus of the department.

FRANKLIN K. LAND,
Secretary.

PART I. LAW AND REGULATIONS.

COAL-LAND LEASING ACT.

The text of the act (38 Stat., 741), approved October 20, 1914, that provides for the leasing of coal lands in the Territory of Alaska is as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior be, and hereby is, authorized and directed to survey the lands of the United States in the Territory of Alaska known to be valuable for their deposits of coal, preference to be given first in favor of surveying lands within those areas commonly known as the Bering River, Matanuska, and Nenana coal fields, and thereafter to such areas or coal fields as lie tributary to established settlements or existing or proposed rail or water transportation lines: Provided, That such surveys shall be executed in accordance with existing laws and rules and regulations governing the survey of public lands. There is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of \$100,000 for the purpose of making the surveys herein provided for, to continue available until expended: Provided, That any surveys heretofore made under the authority or by the approval of the Department of the Interior may be adopted and used for the purposes of this Act.

"SEC. 2. That the President of the United States shall designate and reserve from use, location, sale, lease, or disposition not exceeding five thousand one hundred and twenty acres of coal-bearing land in the Bering River field and not exceeding seven thousand six hundred and eighty acres of coal-bearing land in the Matanuska field, and not to exceed one-half of the other coal lands in Alaska: *Provided*, That the coal deposits in such reserved areas may be mined under the direction of the President when, in his opinion, the mining of such coal in such reserved areas, under the direction of the President, becomes necessary, by reason of an insufficient supply of coal at a reasonable price for the requirements of Government works, construction and operation of Government railroads, for the Navy, for national protection, or for relief from monopoly or oppressive conditions.

"SEC. 3. That the unreserved coal lands and coal deposits shall be divided by the Secretary of the Interior into leasing blocks or tracts of forty acres each, or multiples thereof, and in such form as in the opinion of the Secretary will permit the most economical mining of the coal in such blocks, but in no case exceeding two thousand five hundred and sixty acres in any one leasing block or tract; and thereafter, the Secretary shall offer such blocks or tracts and the coal, lignite, and associated minerals therein for leasing, and may award leases thereof through advertisement, competitive bidding, or such other methods as he may by general regulations adopt, to any person above the age of twenty-one years who is a citizen of the United States, or to any association of such persons, or to any corporation or municipality organized under the laws of the United States or of any State or Territory thereof: *Provided*, That a majority of the stock of such corporation shall at all times be owned and held by citizens of the United States: *And provided further*, That no railroad or common carrier shall be permitted to take or acquire through lease or permit under this Act any coal or coal lands in excess of such area or quantity as may be required and used solely for its own use, and such limitation of use shall be expressed in all leases or permits issued to railroads or common carriers hereunder: *And provided further*, That any person, association, or corporation qualified to become a lessee under this Act and owning any pending claim under the public-land laws to any coal lands in Alaska may, within one year from the passage of this Act, enter into an arrangement with the Secretary of the Interior by which such claim shall be fully relinquished to the United States; and if in the judgment of the Secretary of the Interior, the circumstances connected with such claim justify so doing, the moneys paid by the claimant or claimants to the United States on account of such claim shall, by direction of the Secretary of the Interior, be returned and paid over to such person, association, or corporation as a consideration for such relinquishment.

"All claims of existing rights to any of such lands in which final proof has been submitted and which are now pending before the Commissioner of the General Land Office or the Secretary of the Interior for decision shall be adjudicated within one year from the passage of this Act.

"SEC. 4. That a person, association, or corporation holding a lease of coal lands under this act may, with the approval of the Secretary of the Interior and through the same procedure and upon the same terms and conditions as in the case of an original lease under this Act,

secure a further or new lease covering additional lands contiguous to those embraced in the original lease, but in no event shall the total area embraced in such original and new leases exceed in the aggregate two thousand five hundred and sixty acres.

"That upon satisfactory showing by any lessee to the Secretary of the Interior that all of the workable deposits of coal within a tract covered by his or its lease will be exhausted, worked out, or removed within three years thereafter, the Secretary of the Interior may, within his discretion, lease to such lessee an additional tract of land or coal deposits, which, including the coal area remaining in the original lease, shall not exceed two thousand five hundred and sixty acres, through the same procedure and under the same competitive conditions as in case of an original lease.

"Sec. 5. That, subject to the approval of the Secretary of the Interior, lessees holding under leases small blocks or areas may consolidate their said leases or holdings so as to include in a single holding not to exceed two thousand five hundred and sixty acres of contiguous lands.

"Sec. 6. That each lease shall be for such leasing block or tract of land as may be offered or applied for, not exceeding in area two thousand five hundred and sixty acres of land, to be described by the subdivisions of the survey, and no person, association, or corporation, except as hereinafter provided, shall be permitted to take or hold any interest as a stockholder or otherwise in more than one such lease under this Act, and any interest held in violation of this proviso shall be forfeited to the United States by appropriate proceedings instituted by the Attorney General for that purpose in any court of competent jurisdiction, except that any such ownership and interest hereby forbidden which may be acquired by descent, will, judgment, or decree may be held for two years, and not longer, after its acquisition.

"Sec. 7. That any person who shall purchase, acquire, or hold any interest in two or more such leases, except as herein provided, or who shall knowingly purchase, acquire, or hold any stock in a corporation having an interest in two or more such leases, or who shall knowingly sell or transfer to one disqualified to purchase, or except as in this Act specifically provided, disqualified to acquire, any such interest, shall be deemed guilty of a felony, and upon conviction shall be punished by imprisonment for not more than three years and by a fine not exceeding \$1,000: *Provided*, That any such ownership and interest hereby forbidden which may be acquired by descent, will, judgment, or decree may be held two years after its acquisition and not longer, and in case of minority or other disability such time as the court may decree.

"Sec. 8. That any director, trustee, officer, or agent of any corporation holding any interest in such a lease who shall, on behalf of such corporation, act in the purchase of any interest in another lease, or who shall knowingly act on behalf of such corporation in the sale or transfer of any such interest in any lease held by such corporation to any corporation or individual holding any interest in any such a lease, except as herein provided, shall be guilty of a felony and shall be subject to imprisonment for a term of not exceeding three years and a fine of not exceeding \$1,000.

"Sec. 8a. If any of the lands or deposits leased under the provisions of this Act shall be subleased, trusted, possessed, or controlled by any device permanently, temporarily, directly, indirectly, tacitly, or in any manner whatsoever, so that they form part of or are in anywise controlled by any combination in the form of an unlawful trust, with consent of lessee, or form the subject of any contract or conspiracy in restraint of trade in the mining or selling of coal, entered into by the lessee, or of any holding of such lands by any individual, partnership, association, corporation, or control, in excess of two thousand five hundred and sixty acres in the Territory of Alaska, the lease thereof shall be forfeited by appropriate court proceedings.

"Sec. 9. That for the privilege of mining and extracting and disposing of the coal in the lands covered by his lease the lessee shall pay to the United States such royalties as may be specified in the lease, which shall not be less than two cents per ton, due and payable at the end of each month succeeding that of the shipment of the coal from the mine, and an annual rental, payable at the beginning of each year, on the lands covered by such lease, at the rate of twenty-five cents per acre for the first year thereafter, fifty cents per acre for the second, third, fourth, and fifth years, and \$1 per acre for each and every year thereafter during the continuance of the lease, except that such rental for any year shall be credited against the royalties as they accrue for that year. Leases may be for periods of not more than fifty years each, subject to renewal, on such terms and conditions as may be authorized by law at the time of such renewal. All net profits from operation of Government mines, and all royalties and rentals under leases as herein provided, shall be deposited in the Treasury of the United States in a separate and distinct fund to be applied to the reimbursement of the Government of the United States on account of any expenditures made in the construction of railroads in Alaska, and the excess shall be deposited in the fund known as The Alaska Fund, established by the Act of Congress of January twenty-seventh, nineteen hundred and five, to be expended as provided in said last-mentioned Act.

"Sec. 10. That in order to provide for the supply of strictly local and domestic needs for fuel the Secretary of the Interior may, under such rules and regulations as he may prescribe in advance, issue to any applicant qualified under section three of this Act a limited license or permit granting the right to prospect for, mine, and dispose of coal belonging to the United States on specified tracts not to exceed ten acres to any one person or association of persons in any one coal field for a period of not exceeding ten years, on such conditions not inconsistent with this Act as in his opinion will safeguard the public interest, without payment of royalty for the coal mined or for the land occupied: *Provided*, That the acquisition of holding of a lease under the preceding sections of this Act shall be no bar to the acquisition, holding, or operating under the limited license in this section permitted. And the holding of such a license shall be no bar to the acquisition or holding of such a lease or interest therein.

"Sec. 11. That any lease, entry, location, occupation, or use permitted under this Act shall reserve to the Government of the United States the right to grant or use such easements in, over, through, or upon the land leased, entered, located, occupied, or used as may be necessary or appropriate to the working of the same or other coal

lands by or under authority of the Government and for other purposes: *Provided*, That said Secretary, in his discretion, in making any lease under this Act, may reserve to the United States the right to lease, sell, or otherwise dispose of the surface of the lands embraced within such lease under existing law or laws hereafter enacted in so far as said surface is not necessary for use by the lessee in extracting and removing the deposits of coal therein. If such reservation is made, it shall be so determined before the offering of such lease.

"That the said Secretary during the life of the lease is authorized to issue such permits for easements herein provided to be reserved, and to permit the use of such other public lands in the Territory of Alaska as may be necessary for the construction and maintenance of coal washeries or other works incident to the mining or treatment of coal, which lands may be occupied and used jointly or severally by lessees or permittees, as may be determined by said Secretary.

"SEC. 12. That no lease issued under authority of this Act shall be assigned or sublet except with the consent of the Secretary of the Interior. Each lease shall contain provisions for the purpose of insuring the exercise of reasonable diligence, skill, and care in the operation of said property, and for the safety and welfare of the miners and for the prevention of undue waste, including a restriction of the workday to not exceeding eight hours in any one day for underground workers except in cases of emergency; provisions securing the workers complete freedom of purchase, requiring the payment of wages at least twice a month in lawful money of the United States, and providing proper rules and regulations to secure fair and just weighing or measurement of the coal mined by each miner, and such other provisions as are needed for the protection of the interests of the United States, for the prevention of monopoly, and for the safeguarding of the public welfare.

"SEC. 13. That the possession of any lessee of the land or coal deposits leased under this act for all purposes involving adverse claims to the leased property shall be deemed the possession of the United States, and for such purposes the lessee shall occupy the same relation to the property leased as if operated directly by the United States.

"SEC. 14. That any such lease may be forfeited and canceled by appropriate proceeding in a court of competent jurisdiction whenever the lessee fails to comply with any provision of the lease or of general regulations promulgated under this Act; and the lease may provide for the enforcement of other appropriate remedies for breach of specified conditions thereof.

"SEC. 15. That on and after the approval of this Act no lands in Alaska containing deposits of coal withdrawn from entry or sale shall be disposed of or acquired in any manner except as provided in this Act: *Provided*, That the passage of this Act shall not affect any proceeding now pending in the Department of the Interior, and any such proceeding may be carried to a final determination in said department notwithstanding the passage hereof: *Provided further*, That no lease shall be made, under the provisions hereof, of any land, a claim for which is pending in the Department of the Interior at the date of the passage of this Act, until and unless such claim is finally disposed of by the department adversely to the claimant.

"SEC. 16. That all statements, representations, or reports required, unless otherwise specified, by the Secretary of the Interior under this Act shall be upon oath and in such form and upon such blanks as the Secretary of the Interior may require, and any person making false oath, representation, or report shall be subject to punishment as for perjury.

"SEC. 17. That the Secretary of the Interior is authorized to prescribe the necessary and proper rules and regulations and to do any and all things necessary to carry out and accomplish the purposes of this Act.

"SEC. 18. That all Acts and parts of Acts in conflict herewith are hereby repealed."

COAL LANDS RESERVED.

The President of the United States is required by section 2 of the leasing act to "designate and reserve from use, location, sale, lease, or disposition, not exceeding 5,120 acres of coal-bearing land in the Bering River field, and not exceeding 7,680 acres of coal-bearing land in the Matanuska field," before opening the fields under the provisions of the act. The unreserved coal lands are thereafter to be "divided by the Secretary of the Interior into leasing blocks or tracts of 40 acres each or multiples thereof, and in such form as, in the opinion of the Secretary, will permit the most economical mining of the coal in such blocks, but in no case exceeding 2,560 acres in any one leasing block or tract." The lands having been thus divided into leasing blocks, the Secretary under the act is authorized, then and not before, to offer such blocks or tracts for leasing and award leases thereof through such plan as he may adopt, either by advertisement, competitive bidding, or otherwise.

It is recognized that if the Government were to reserve the total acreage allowed by law and were to select those areas that are believed to be best suited for profitable mining, the result might be to prevent effectually coal mining in Alaska until such time as the Government itself might undertake mine development and operation. The intention of Congress in passing the Alaska coal-leasing law is believed to have been the promotion of the mining of coal in the Territory as early as possible to meet the demands of the Government railroad, the Navy, and Alaskan consumers. The legal provision for Government reservation furnishes a means for safeguarding the public interest in the future, when lack of competition or other exigency may necessitate Government operation. The tracts now selected for reservation in accord with this policy are therefore such as are believed to possess the average rather than the highest value.

The President has therefore designated and reserved from use, location, sale, lease, or disposition the lands described as follows:

Lands reserved in Matanuska field, Seward base and meridian.

- (1) T. 19 N., R. 6 E.: N. $\frac{1}{2}$ NE. $\frac{1}{4}$ and N. $\frac{1}{2}$ NW. $\frac{1}{4}$ sec. 4;
NE. $\frac{1}{4}$ NE. $\frac{1}{4}$, W. $\frac{1}{4}$ NE. $\frac{1}{4}$ and NW. $\frac{1}{4}$ sec. 5.
T. 20 N., R. 6 E.: Lot 6 and E. $\frac{1}{2}$ SE. $\frac{1}{4}$ sec. 31;
Lots 4, 5, 6, and 7 and SE. $\frac{1}{4}$ and SW. $\frac{1}{4}$ sec. 32;
Lots 3, 4, 5, and 6, S. $\frac{1}{2}$ SE. $\frac{1}{4}$, and SW. $\frac{1}{4}$ sec. 33, containing
1,446.17 acres.

- (2) T. 20 N., R. 6 E.: NE. $\frac{1}{4}$, SE. $\frac{1}{4}$, E. $\frac{1}{4}$ NW. $\frac{1}{4}$ and E. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 20;
NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, SE. $\frac{1}{4}$ and S. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 21;
SW. $\frac{1}{4}$ and S. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 22;
NW. $\frac{1}{4}$ sec. 27;
NE. $\frac{1}{4}$ and NW. $\frac{1}{4}$ sec. 28;
E. $\frac{1}{4}$ NE. $\frac{1}{4}$ and NW. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 29, containing 1,880 acres.

Lands reserved in Bering River field, Copper River base and meridian.

- (3) T. 16 S., R. 8 E.: Secs. 23 and 24, containing 1,280 acres.
(1) T. 16 S., R. 8 E.: NE. $\frac{1}{4}$, SE. $\frac{1}{4}$ and SW. $\frac{1}{4}$, sec. 33.
T. 17 S., R. 8 E.: N. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 3;
All of sec. 4;
E. $\frac{1}{4}$ NE. $\frac{1}{4}$ and E. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 5;
E. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 8;
N. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 9, containing 1,520 acres.
(b) T. 17 S., R. 7 E.: Lot 3 and SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 8;
Lots 1 and 2, SE. $\frac{1}{4}$ NW. $\frac{1}{4}$, SW. $\frac{1}{4}$ and W. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 9;
NW. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 16;
SE. $\frac{1}{4}$, NE. $\frac{1}{4}$, NW. $\frac{1}{4}$ and W. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 17;
NE. $\frac{1}{4}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$ NW. $\frac{1}{4}$, E. $\frac{1}{4}$ SW. $\frac{1}{4}$ and lots 3 and 4 sec. 18,
containing 1,566.08 acres

All of the coal land in the remainder of these fields is open to application for lease, and none of this open territory will be withdrawn or reserved while there is any bona fide application for a lease thereon.

UNRESERVED LANDS.

As noted in the foregoing statement the *unreserved* lands in the coal fields must be divided by the Secretary into leasing "blocks" or "tracts," before he can make a leasing offer. A survey of said lands in accordance with the system of public-land surveys is therefore necessary, as the act requires each leasing block or tract to be described by subdivisions of the survey. To this end such a survey of the Bering River and Matanuska fields has been made and the known coal lands in these fields divided into leasing blocks, as shown on the maps of these fields (in pocket).

GENERAL REGULATIONS.

(1) By authority of the act of Congress approved October 20, 1914 (38 Stat., 741), the unreserved surveyed coal lands in the Bering River and the Matanuska coal fields, Alaska, have been divided into leasing blocks, or tracts, of 40 acres, or multiples thereof, and leases of such blocks or tracts, with the privilege of mining and disposing of the coal, lignite, and associated minerals therein may be procured from the United States in the following manner:

(2) On request, addressed to the Commissioner of the General Land Office at Washington, D. C., a blank application and lease will be furnished the applicant; also, those who desire may procure from the Superintendent of Documents, Government Printing Office, Washington, D. C., a folio containing photolithographic copies of the approved plats of the topographic and subdivisional township surveys of the Matanuska field (13 townships) for \$1, and of the Bering River field (8 townships) for 75 cents.

(3) From and after June 1, 1916, for a period of 30 days, applications for coal-mining leases will be received at the General Land Office from duly qualified applicants.

Under this act the qualifications of such lessees are defined as follows:

(a) Any person above the age of 21 who is a citizen of the United States;

(b) Any association of such persons (that is, citizens of the United States over 21 years of age);

(c) Any corporation or municipality organized under the laws of the United States, or of any State or Territory thereof, "Provided, That a majority of the stock of such corporation shall at all times be owned and held by citizens of the United States."

(4) The total area that may be embraced in one lease is fixed at 2,560 acres, which may include one or more contiguous leasing blocks, or tracts, as shown on the map; and no person, association, or corporation is permitted to take or hold any interest as a stockholder or otherwise in more than one lease under this act.

(5) The application blank calls for information as to the name of the applicant, a description of the leasing block or blocks desired, amount of capital proposed as an investment under the lease, time when actual development under the lease will begin, experience in coal mining, and reference as to financial standing.

(6) The statute under which these proceedings are authorized provides that the Secretary of the Interior may award leases "through advertisement, competitive bidding, or such other methods as he may by general regulation adopt," and the purpose of the applications required herein is to procure such information as will best enable the Secretary to award leases so as to procure the best terms on behalf of the United States, and the most effective development of the coal deposits of the Territory.

(7) When the time fixed for filing such applications shall have expired, all applications then on file will be promptly listed and the proposed terms thereunder will be noted. Thereafter due publication, at the expense of the Government, for a period of 30 days will follow in at least three of the leading trade journals, one each at New York, Pittsburgh, and Chicago, and for the same period of time in three newspapers of general circulation, one each at San Francisco, Seattle, and Juneau, of the applications filed, each to be designated by a number and not by the name of the applicant, the blocks or block applied for, with the announcement that at the expiration of the period of publication the said applications will be taken up and the proposals therein considered, subject to any better terms that may be offered by any other qualified applicant during the period of publication, or by the first applicant.

(8) All applications for a lease, or proposals in connection therewith, pending at the expiration of the period of publication will be submitted to the Secretary of the Interior in one report, with specific recommendations as to the awards that should be made or denied under the several applications or proposals; and thereafter such action will be taken by the Secretary on the report as may in his discretion seem warranted on the showing made in each case, by which he will obtain the largest investment proportionate to the acreage of the lease, and the earliest actual development of the coal mine on a commercial basis, reserving the right to modify proposed leasing blocks, or tracts, if the economical mining of the coal will

better be procured thereby, or finally to reject any or all applications if, in his judgment, the interests of the United States so require.

(9) An actual beneficial expenditure on the ground for mining development and improvement purposes of \$100 for each acre included within the lease for which application is made will be adopted as the minimum basis upon which the proposed investments of the several applicants will be considered and adjudged, with the requirement that not less than one-fifth of the proposed investment shall be expended in the development of the mine during the first year, and a like sum each succeeding year, for the period of four years following the execution of the lease; excess investments in any year over such proportionate amount to be credited on the expenditure called for in the year ensuing. A bond, to be executed within 10 days after the signature of the lease, in the sum of one-half the amount to be expended each year will be required of each lessee conditioned upon the expenditure of such sum within said period.

(10) The procedure prescribed in the foregoing is to procure the orderly consideration of all applications or proposals that may be submitted in accordance with the foregoing regulations and within the period of time therein fixed; but when final action shall have been taken by the department upon the applications or proposals thus submitted any qualified applicant may thereafter apply for a leasing block or tract, and his application will be received and disposed of in the same manner and after like publication as herein provided.

(11) Lands found to contain coal but not divided into leasing blocks may be hereafter divided into such blocks, and the lands therein made the subject of a leasing offer, the rights of adjacent lessees to be given due consideration in any award that may be made under such offer.

PROSPECTING.

The coal-leasing act makes no provision for the right of an intending lessee to enter upon and explore coal fields embraced within a lease offer prior to submission of his application for a lease.

Such a right, if existent, would by implication carry with it some protection from the interference of others while engaged in such inspection as well as the exclusive benefit of any discoveries made thereby and amount in effect to a preference right based upon discovery; otherwise the right of exploration would be an empty privilege.

The entire scheme of section 3 of the act which governs the manner in which leases shall be awarded goes upon the theory that the Government is to offer "known" coal lands for leasing without priority of right recognized in either discovery, "opening a mine," or application, and "awarding leases thereof through advertisement, competitive bidding, or such other methods as he (the Secretary of the Interior) may by general regulations adopt."

All prospective applicants, however, will be accorded every opportunity to enter upon, inspect, and explore these coal fields at their pleasure in so far as such action may be necessary to acquire a thorough knowledge of field conditions, but no possessory or other right, either as against other prospectors or applicants or the United States, shall be acquired thereby.

USE OF TIMBER.

The use of timber by the lessee, in addition to that taken from the leasehold under the terms of the lease, may be secured by him from other lands not embraced in leasing units in accordance with the regulations that may be prescribed by the Secretary of the Interior under the act of May 14, 1898 (30 Stat., 414), and the acts amendatory thereof; or by arrangement with the Department of Agriculture, if from a national forest.

LEASES AND PERMITS AND APPLICATIONS THEREFOR.

COAL-MINING LEASE.

Date. THIS INDENTURE OF LEASE, entered into, in quintuplicate, this _____ day of _____ A. D., 19____, by and between the United States of America, acting in this behalf by _____, Secretary of the Interior, party of the first part, hereinafter called the lessor, and _____ party of the second part, hereinafter called the lessee under and pursuant to the act of Congress, approved October 20, 1914 (38 Stat., 741), entitled "An act to provide for the leasing of coal lands in the Territory of Alaska, and for other purposes," hereinafter called the "coal leasing act,"

WITNESSETH.

Purposes That the lessor, in consideration of the rents and royalties to be paid and the covenants to be observed as hereinafter set forth, does hereby grant and lease to the lessee, for the period of fifty years from the date hereof, the exclusive right and privilege to mine and dispose of all the coal and associated minerals in, upon or under the following described tracts of land, situated in the Territory of Alaska, to wit: _____

Description of land. _____ containing _____ acres, more or less, together with Mining and surface rights. _____ the right to construct coke ovens, briquetting plants by-products plants, and all such other works as may be necessary and convenient for the mining and preparation of coal and associated minerals for market, the manufacture of coke or other products of coal, and to use so much of the surface and the sand, stone, timber and water thereon as may reasonably be required in the exercise of the rights and privileges herein granted the use of such timber to be subject to such regulations as may be prescribed by the Secretary of the Interior under the act approved May 14, 1898 (30 Stat., 414), and the acts amendatory thereof.

ARTICLE I.

SECTION 1. The lessor expressly reserves unto itself the right to grant or use such easements in, over, through or upon the land leased, entered, located, occupied, or used as may be necessary or appropriate to the working of the same or other coal lands by or under authority of the Government and for other purposes; also the right to use, lease, or dispose of so much of the surface of the said lands as may not be actually needed, or occupied by the lessee in the conduct of mining operations. ^{Rights reserved by lessor.}

ARTICLE II.

It is expressly understood and agreed, that this lease is granted subject in all respects to the conditions, limitations, penalties and provisions contained in the "Coal Leasing Act," which act is hereby made a part hereof to the same extent as if incorporated herein. ^{Lease subject to "Coal Leasing Act."}

ARTICLE III.

It is further expressly understood and agreed that the mining rights and privileges leased as aforesaid shall extend to and include only coal and associated minerals, as hereinafter defined, and that no rights or privileges respecting any other kind or character of mineral, or mineral substance whatsoever, are granted or intended to be granted by this lease. ^{Mining rights limited to coal and associated minerals.}

ARTICLE IV.

The lessee in consideration of the lease of the rights and privileges aforesaid hereby covenants and agrees as follows:

SECTION 1. To invest in actual mining operations upon the leasing block included herein, the sum of ----- ^{Investment.}

----- dollars, of which sum not less than one-fifth shall be so expended during the first year succeeding the execution of this instrument, and a like sum each succeeding year for the period of four years; to furnish a bond, within 10 days after signature of the lease, in the sum of one-half the amount to be expended each year, conditioned upon the expenditure of such sum within said period, and submit annually, at the expiration of each year for the said period, an itemized statement, as to the amount and character of the expenditure during said year.

SEC. 2. To pay as an annual rental for each acre or part thereof covered by this lease, the sum of 25 cents per acre for the first year, payment of which amount is hereby acknowledged, the sum of 50 cents per acre per year for the second, third, fourth, and fifth years, and \$1 per acre for the sixth and each succeeding year during ^{Annual rental.}

the life of this lease, all such annual payments of rent to be made on the anniversary of the date hereof, and to be credited on the first royalties to become due hereunder during the year for which said rental was paid.

Royalty.

SEC. 3. To pay a royalty of 2 cents on every ton of 2,000 pounds of coal shipped or removed from the leased lands or manufactured into coke, briquets or other products of coal, or consumed on the premises, during the first five years succeeding the execution of this lease and 5 cents per ton for the next 20 years. Royalty shall be payable at the end of each calendar month next succeeding that of the said shipment, removal, donation, manufacture or consumption.

Lessee to keep record of all coal shipped.

SEC. 4. To accurately weigh all coal shipped or removed from the leased premises, sold, or donated for local trade, manufactured into coke, briquets, or other products of coal, or otherwise consumed or utilized, and to accurately enter the weight or weights thereof in due form in books to be kept and preserved by the lessee for such purpose, together with the car numbers, if any, of the coal shipped by rail.

Reports to be furnished monthly by lessee

SEC. 5. To furnish in manner and form and at such time during each calendar month as the lessor shall prescribe, but in no event later than the last day thereof the following written reports covering the month immediately preceding, certified under oath by the superintendent at the mine, or by such other agent on the property having personal knowledge of the facts as may be designated by the lessee for such purpose, to wit:

A report copied from the books required to be kept at the mine under section 4 of this article showing the fact required to be entered therein; a report of the number of mine cars of mine-run coal hoisted or trimmed from each coal bed of each separate mine; a report showing the quantity, size, and character of coal shipped, used for power purposes and lease consumption; donated to employees, manufactured into coke, briquets, or other products or by-products of coal; in storage on the premises, with the quantity of coal of various sizes added thereto and taken therefrom during the month.

ARTICLE V.

Periods for readjustment of royalty.

It is mutually understood and agreed that the lessor shall have the right to readjust and fix the royalty payable hereunder at the end of 25 years from the date hereof, and at the end of 15 years thereafter, and thereafter at the end of each succeeding 10-year period during the continuance of this lease: *Provided*, That in any such readjustment the royalty fixed shall not exceed 5 per cent of the average selling price of coal of like character at the mine, per ton of 2,000 pounds in the coal field embracing the tracts covered by this lease, as shown by the books of the lessees operating in said field during a period of five years next preceding such readjustment.

ARTICLE VI.

This lease is made subject to the following provisions, which the lessee accepts and covenants faithfully to perform and observe:

SECTION 1. The lessee shall diligently proceed to prospect for, develop, and mine the coal in or upon the leased lands; shall carry on all mining operations in a good and workmanlike manner, having due regard to the health and safety of miners and other employees; and shall leave no available coal abandoned which could be recovered by the most approved methods of mining when in the regular course of mining operations the time shall arrive for mining such coal. No mine, entry, level, or group of rooms or workings shall be permanently abandoned and rendered inaccessible, save with the approval of the authorized representative of the lessor.

Abandoned operations to be encouraged.

Workings not to be abandoned until examination made.

SECT. 2. And also shall develop and mine the coal in the leased lands in accordance with a system to be shown by a preliminary plan on a scale of not more than 200 feet to the inch and a written description thereof, which plan and description shall be submitted for approval by the authorized representative of the lessor.

Preliminary plan of mining to be submitted in advance of operations on a commercial scale.

SECT. 3. And also where more than one bed of coal is known to exist in the leased lands, shall not draw or remove the pillars in any lower bed, before the available coal in any or all upper beds has been mined, unless it shall be decided by the authorized representative of the lessor that the workings in any or all of the upper beds will not be seriously injured by the extraction of the pillar coal in the lower workings. Where mining operations are being carried on in a bed that lies either below or above another bed in which mining has been or is being carried on and in which the pillars have not been pulled, and where the vertical distance between the two beds is less than fifteen times the thickness of the lower of the two beds, the lessee shall, as far as practicable, so arrange the pillars that those in the lower bed shall be vertically beneath those in the upper bed. Where practicable, by reason of either commercial or mining conditions, the available coal in the upper beds shall be exhausted before the coal in the lower beds is mined.

Where two or more beds of coal pillars in lower beds to be left until coal in upper beds extracted. Exceptions.

Pillars in lower beds to be arranged vertically under pillars in upper beds.

SECT. 4. And also shall not, without the consent in writing of the authorized representative of the lessor first had and obtained, mine any coal, or drive any underground workings, or drill any lateral bore hole within 50 feet of any of the outside boundary lines of the leased lands, nor within such greater distance of such boundary lines, as the said representative shall prescribe for the protection of the property or the safeguarding of mining operations hereunder; but in the event the coal up to the like barrier in adjoining premises shall have been worked out and exhausted, and the water therein shall have been lowered below the working level of the opera-

Fifty foot barrier pillars.

Lessee may be required to mine barrier pillars on adjacent lands.

Requirements
for map of surface
over workings.

The map of the surface immediately over the mine workings shall show all prominent topographic features and culture, section and township lines, the elevations above sea level or an approved datum, and contours at vertical intervals of 25 feet of such topographic features. Such map, together with the maps of the underground workings, shall be brought up to date not less than once in every six months.

Things to
be shown on general
property map to
be kept at mine
office.

The lessee shall also make and keep at the mine office, at such time after the commencement of mining operations as the authorized representative of the lessor may direct, a clear and accurate general map of the entire leased lands, on a scale of 400 feet to the inch. Such map shall show all prominent topographical features and culture; the location of the surface areas immediately over the mine workings shown on the detailed surface map hereinbefore required, township, section, and property lines; the location of high-water marks; the outline of coal outcrops where known; the outline of the chief mine workings, indicating the workings in each separate coal bed by distinguishing marks and the elevations above sea level or an approved datum, and contours at vertical intervals of 25 feet of the chief topographic features. Such map shall be brought up to date not less than once in every six months.

Prints of maps
to be furnished
lessor.

Blue prints or reproductions in duplicate of the maps required as aforesaid shall be furnished the authorized representative of the lessor when made, and supplemental prints or reproductions in duplicate furnished on or before January 1 of each succeeding year, showing the extensions, additions, and changes since the last map or supplement was submitted. All mine progress maps kept by the lessee shall at all times be subject to examination by said representative.

Abandoned
areas to be sur-
veyed and
mapped.

The lessee whenever any mine, or any workings therein are to be abandoned or indefinitely closed, and before mine shall be abandoned or closed, or allowed to become inaccessible, shall make a survey thereof so as to accurately show the entire worked-out area or areas, and shall extend the results of such survey on the map or maps of the underground workings hereinbefore required, and promptly forward blue prints or reproductions thereof in duplicate to the said representative.

Maps may be
made at lessee's
expense in case
of failure to fur-
nish.

If the lessee shall fail to make or furnish any map or extension or revision as herein required within 60 days after demand therefor shall have been made by the authorized representative of the lessor, such representative may employ a competent engineer to make a survey of the mine, and plat the same as above provided, the expense thereof to be paid by the lessee, and in the event that the lessee shall fail to make such payment within 60 days after demand therefor by the authorized representative of the lessor, such failure shall constitute a cause of forfeiture of this lease.

Sec. 9. And also shall, where more than ten men are employed underground on any one shift in any separate mine, provide an escapeway or second exit to the surface, which shall be separated at the surface from the first exit by not less than 50 feet of strata in case of drift, slope, or tunnel workings, or in case of vertical shafts, or of inclined shafts having a pitch of more than 45°, by not less than 200 feet of strata. An escapeway or outlet through an adjoining mine shall be regarded as a satisfactory compliance with this requirement if kept at all time in proper condition for use. If such adjoining mine shall be abandoned at any time, or shall cease to operate indefinitely, the lessee hereunder shall be solely responsible for the cost and expense of maintaining such outlet, and in the event such outlet shall be abandoned or permitted to become unsafe for use, the number of men employed on any one shift shall be reduced below ten until such time as a second exit or escapeway shall be provided.

Second exit to surface to be provided, where more than 10 men employed on a shift.

Outlet through adjacent mine sufficient compliance

Sec. 10. And also shall not employ more than five men underground on any one shift in any new working of any mine unless such new working shall be so connected with adjacent workings as to provide two distinct and separate means of escape from such new working: *Provided*, That with the approval of the authorized representative of the lessor, not exceeding ten men may be so employed in advance of the making of such second opening, but in no case shall any rooms, drifts, or slopes be opened or worked until such second opening is constructed.

Not more than five men to be employed in new workings unless a second opening provided.

Exceptions.

Sec. 11. And also shall not construct or maintain any structure of inflammable material within 75 feet of any mine opening; nor within said distance permit any structure of noninflammable material to be connected to any other structure by means of any structure or erection of inflammable material, or to be connected to any structure beyond said distance which shall be constructed of inflammable material, except as follows, that is to say:

No building of inflammable material to be constructed within 75 feet of any mine

(a) An open timber framework or headframe of timber may be constructed over a shaft, slope, or incline.

Exceptions.

(b) The posts, studs, and rafters of any such structure may be of wood if the covering or lining is made of non-inflammable material, but under no circumstances shall wood flooring be used, except in tippie and trestle structures.

Sec. 12. And also, except in a prospect opening, shall separate the main intake and return airways and all workings parallel to such airways by not less than 50 feet of strata except for break-throughs or crossovers for ventilation or haulage, and shall provide for such greater distance between such airways or between any such airway and parallel workings as may be required in the judgment of the authorized representative of the

Main intake and return airways to be separated by not less than 50 feet of natural strata.

Pillars to be left standing until prior to final abandonment of mine

Ventilating fan to be provided where more than 10 men employed on shift.

Fan not to be placed in direct line with any mine entrance.

With written approval of lessor's representative furnace may be used for ventilation under specified conditions.

Slack and refuse to be disposed of so as not to become a public or private nuisance.

Abandoned workings to be covered or fenced.

lessor. The lessee agrees that the pillars thus provided for shall be left standing until in the proper course of mining operations the time shall arrive for their removal immediately prior to the final abandonment of the workings in that particular coal bed.

Sec. 13. And also shall whenever more than ten men are employed underground on any one shift provide a fan or other mechanical means for circulating such amount of ventilating current as may be required by any law of the United States or of the Territory of Alaska now or hereafter enacted, or by the rules and regulations prescribed by the lessor, such fan or other mechanical means and the connection between same and the point of the entrance of the air current into the mine to be made of noncombustible material; and the lessee shall not set same in line with the axis of any mine opening, but shall place same at a distance of not less than 15 feet from the projection of the nearest side of such opening, and shall provide explosion doors of the full area of the air shaft or airway, in direct line with any and all such mine openings in order to protect said fan or other mechanical means of air circulation in case of a mine explosion: *Provided*, That during such time as the mine is being opened up and less than ten men are employed underground on any one shift, and with the written approval of the authorized representative of the lessor, a furnace may be used for ventilation in a noncombustible mine if the fire box thereof is inclosed by brick, rock, or concrete walls, and a passageway around such inclosure at least two feet in width provided: *And provided further*, That if a wooden stack is used in connection with such furnace the lessee shall not permit such stack to be in contact with any coal bed or with any inflammable shale.

Sec. 14. And also shall make such provisions for the disposal of the waste, slack, and refuse of the mine that the same shall not be a nuisance, inconvenience, or obstruction to any right of way, stream, or other means of transportation or travel, or to any private or public lands, or embarrass the operation of any other mine on the leased lands, or on adjoining lands, or in any manner occasion private or public damage, nuisance, or inconvenience. All waste containing practically no coal shall be deposited separate and apart from waste containing coal and in accordance with the directions of the authorized representative of the lessor.

Sec. 15. And also shall upon abandonment substantially fence, fill in, cover, or close all surface openings or workings where persons or animals are likely to be injured by falling therein, or endangered by accumulations of gas, except as the lessor shall otherwise direct; and shall maintain all such fencing or covering in a secure condition during the term hereof.

Sec. 16. And also expressly agrees that all mining and related operations shall be subject to the inspection of authorized representatives of the lessor, and that such representatives, with all proper and necessary assistants, may at all reasonable times enter into and upon the leased lands and survey and examine same and all surface and underground improvements, works, machinery, equipment, and operations, and further expressly agrees to furnish said representatives and assistants all necessary assistance, conveniences, and facilities in making any such survey and examination.

Sec. 17. And also shall permit any authorized representative of the lessor to examine all books and records pertaining to operations under this lease, and to make copies of and extracts from any or all of same, if desired. The information so derived to be held confidential.

Sec. 18. And also shall permit the lessor, its lessees, or transferees to make and use upon or under the leased lands any workings necessary for freeing any other mine from water, causing as little damage or interference as possible to or with the mine or mining operations of the lessee hereunder. Any such use by a lessee or transferee shall be conditioned upon the payment to the lessee hereunder of the amount of actual damages sustained thereby and adequate compensation for such use.

Sec. 19. And also shall accurately weigh or measure in the car and truly account for the coal mined and loaded by each miner, where the miners are paid either by the weight of their output or upon the basis of the measurement of the coal in the car; keep a correct record of all coal so weighed or measured; post or display such record daily for the inspection of the miners and other interested persons; and require the weighman or person appointed to measure the coal in the car where the miners are paid upon the basis thereof, before entering upon his duties, to make and subscribe to an oath before some person duly authorized to administer oaths that he will accurately weigh or measure and keep true record of the coal so weighed or measured and credit same to the miner entitled thereto, such affidavit to be kept conspicuously posted at the place of weighing, if any, but nothing contained herein shall be construed to prevent the lessee, in case rock and bone is loaded by the miner, from estimating or separately weighing, and deducting the amount thereof from the weights of coal accredited to such miner. The lessee hereby agrees that if a majority of the miners employed on the leased lands so desire they shall be permitted to employ at their own expense one of their fellow employees to see that the coal is properly weighed or measured and that a correct account of same is kept, and agrees to afford such person every facility to certify the weights and measurements while the weighing or measuring is being done; Pro-

Check weigh-
man to take oath
for faithful dis-
charge of his
duties.

provided, That the lessee shall not be required to so do unless such person, before entering upon his duties, shall make and subscribe to an oath before some person authorized to administer oaths that he will faithfully discharge the duties of his position, such oath to be kept conspicuously posted at the place of weighing, if any.

Wages to be
paid in lawful
money.

Sec. 20. And also shall pay all miners and other employees, both above and below ground, at least twice each month in lawful money of the United States, and shall permit such miners and other employees full and

Freedom of
purchase to be
allowed.

complete freedom of purchase, but with a view to increasing safety this provision shall not apply to the purchase of explosives, detonators or fuses, and shall not require or permit miners or other employees, except in case of emergency, to work underground for more than eight consecutive hours in any one calendar day, not including time for lunch or meals, or the time required to reach the usual working place.

Eight-hour
work day to
be observed

Sec. 21. And also shall, at the expiration or earlier termination of this lease, deliver up to the lessor the lands covered by this lease, together with all fixtures, improvements, and appurtenances, save as hereinafter provided, in such a secure and proper state that mining operations may be continued immediately to the full extent and capacity of such mine.

Premises to be
surrendered in
proper condition
for continuance of
mining opera-
tions.

ARTICLE VII.

It is further mutually understood and agreed as follows:

Suspension of
operations for
more than three
months without
consent to be
cause of forfeit-
ure

SECTION 1. That the suspension of mining operations by the lessee for a longer period than three months without the consent in writing of the lessor or its authorized representatives shall be cause of forfeiture of this lease.

If the lessee shall be unable to continue the operation of the mine for any cause, not due to the fault or negligence of the lessee, he shall be entitled to the suspension of operations for such a length of time, and upon payment of such minimum royalties, and such other conditions as may be specified in the order of suspension, but the issuance of any such order shall not excuse the payment of any rents or royalties due under this lease, or prevent forfeiture for failure to pay same, and the acceptance of any such rent or royalty shall not waive any other right of the lessor hereunder.

Lease not to be
assigned without
consent of lessor.

Sec. 2. That the lessee shall not assign this lease or any interest therein, nor sublet any portion of the leased premises, or any of the rights and privileges herein granted, without the written consent of the lessor being first had and obtained.

Breach of lease
covenants may be
waived in writ-
ing.

Sec. 3. That the lessor or its authorized representative may by notice in writing waive any breach of the covenants and conditions contained herein, except such as are required by the aforesaid "coal leasing act," but any such waiver shall extend only to the particular

breach so waived, and shall not limit the rights of the lessor with respect to any future breach. No waiver not in writing shall be in any way binding upon the lessor.

Sec. 4. That the lessee may terminate this lease at any time upon giving four months' notice in writing to the lessor or its authorized representative, and upon payment of all rents, royalties, and other debts due and payable to the lessor, and upon payment of all wages or moneys due and payable to the workmen employed by the lessee, but in no case shall such termination be effective until the lessee shall have made provision for the preservation of any mine on the leased lands in accordance with the provisions of this lease. *Provided*, That in such case the right of valuation and purchase, accorded the lessor in the section next following (5), shall be exercised within said period of four months.

Lessee may be terminated at any time upon payment of rents, etc.

Termination not to be effective until property examined.

Sec. 5. That at the expiration or earlier termination of this lease all tools, machinery, and equipment, including trucks, rails, and pipe placed by the lessee in the mine or on the property, shall before removal from normal position, if requested by the lessor or its authorized representatives, be valued by three disinterested and competent persons to be chosen in the manner hereinafter provided for the appointment of arbitrators, the valuation of the so three or of a majority of them to be conclusive of the value of any or all of the said property; and the lessor or its agent, licensee, or lessee shall have the right to purchase within four months thereafter any or all such tools, machinery, equipment, or materials at the said valuation, deducting therefrom all rents, royalties, or other payments at that time due and payable by the lessee. If such valuation shall not be requested or the purchase shall not be made within said time the lessee shall have the privilege of removing same from the premises within one year from the expiration or termination of this lease, provided all debts and moneys specified in section 4 of this article shall have been paid. The lessee shall not, and hereby covenants not to, remove any mine supports, timbers, or props in place. All buildings and improvements erected upon the leased lands shall become a part of the property, and machinery and equipment shall not be removed therefrom in such a way as to cause any permanent injury to such buildings or improvements.

Lessor to have privilege of valuing and purchasing equipment, etc., on termination of lease.

Lessee may remove same within year.

Sec. 6. That if the lessee shall make default in the performance or observance of any of the terms, covenants, and stipulations of this lease, and such default shall continue for 60 days after service of written notice thereof by the lessor or its authorized representatives, then all the rights and privileges of the lessee cease and determine, and the lessor may, by appropriate proceedings, have this lease forfeited and canceled in a court of competent jurisdiction.

Forfeiture of lease.

A waiver of any particular cause of forfeiture shall not prevent the cancellation and forfeiture of this lease for

any other cause of forfeiture or for the same cause occurring at any other time.

Questions which may be submitted to arbitration.

SEC. 7. That in case any dispute shall arise between the lessor and lessee as to any question of fact, or as to the reasonableness of any requirement made by the lessor under the provisions of this lease, in the matter of operation, methods, means, expenditures, use of equipment, compensation for joint occupancy by another lessee of a portion of the leased premises, or such other questions as are not determined by express statutory provision, such questions or disputes shall be settled by arbitration in the manner provided for by this section, and the lessor and lessee hereby covenant and agree each with the other to promptly comply with and carry out the decision or award of each and every board of arbitration appointed under this section.

Manner of appointing arbitrators.

Questions in dispute to be determined by arbitration hereunder shall be referred to a board of arbitration consisting of three competent persons, one of which persons shall be selected by the lessor or its authorized representative, and one by the lessee, and the third by the two thus selected: *Provided*, That the lessor and lessee may agree upon one sole arbitrator or upon the third arbitrator. The party desiring such arbitration shall give written notice of the same to the other party, stating therein definitely the point or points in dispute, and name the person selected by such party hereto within 20 days after receiving such notice to name an arbitrator; and in the event it does not do so, the party serving such notice may select the second arbitrator and the two thus named shall select the third arbitrator. The arbitrators thus chosen shall give to each of the parties hereto written notice of the time and place of hearing, which hearing shall not be more than 30 days thereafter, and at the time and place appointed shall proceed with the hearing unless for some good cause, of which the arbitrators or a majority of them shall be the judge, it shall be postponed until some later day or date within a reasonable time. Both parties hereto shall have full opportunity to be heard on any question thus submitted, and the written determination of the board of arbitration thus constituted or of any two members thereof or, in case of the failure of any two members to agree, then the determination of the third arbitrator shall be final and conclusive upon the parties in reference to the questions thus submitted. All such determinations shall be in writing, and a copy thereof shall be delivered to each of such parties.

Decision of third arbitrator to be final.

New board to be chosen in event of failure of arbitrators first selected to choose a third.

It is further agreed that in the event of the failure of the lessor and lessee, or of the two arbitrators selected as aforesaid by the parties hereto, within 20 days from notice to them of their selection, to agree upon the third

When the Secretary of the Interior shall appoint an arbitrator.

Third arbitrator shall receive not to exceed \$500 as full compensation for his services and for all connected therewith, exclusive of transportation; but such compensation shall not be in excess of \$150 for any arbitration. The losing party to the arbitration shall be liable for the payment of such compensation and transportation expenses of such third arbitrator.

That any notice in writing as to any matter in this lease, addressed to the lessee and left with the superintendent, manager, or other person in charge of the mine or of the mine office, shall have the same force and effect as if given to the lessee, and 15 days shall be considered as notice, unless a longer notice be herein provided or so provided in such notice.

ARTICLE VIII.

That the parties hereto expressly agreed and declared that the phrases hereinafter mentioned shall have the meanings hereinafter assigned unless the context shall require, that is to say:

Phrase "available coal" as used in this lease shall mean merchantable coal from any coal bed which can be mined in the prosecution of the lessee's operations at a reasonable profit by the lessee, by the use of machinery and methods which at that time are efficient.

Term "mine" as used herein shall mean and include all underground workings now or hereafter worked for the purpose of mining and removal of associated minerals, together with all buildings, machinery, and equipment, above and below ground, in connection with such mining operations.

Term "pit" or "open pit" shall mean and include all open-pit mining operations or any open-air workings.

Term "coal" as used herein shall mean and include bituminous, subbituminous, lignite, and graphitic coal, lignite, and such heavy coal as is suitable for use as fuel.

Term "associated minerals" as used herein shall mean and include fire clay, shale, sandstone, and the other minerals of the coal measures, exclusive of gold and other metalliferous deposits.

Term "lessee" as used herein shall mean and include the lessee, his heirs, executors, administrators, successors, and assigns of the lessee hereinbefore specified.

ARTICLE IX.

It is further mutually covenanted and agreed that each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

ARTICLE X.

It is also further agreed that no member of or delegate to Congress or resident commissioner, after his election or appointment, or either before or after he has qualified, and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, shall be admitted to any share or part in this lease, or derive any benefit that may arise therefrom, and the provisions of section 3741 of the Revised Statutes of the United States and sections 114, 115, 116 of the Codification of the Penal Laws of the United States approved March 4, 1909 (35 Stat., 1109) relating to contracts enter into and form a part of this lease so far as the same may be applicable.

In witness whereof—

THE UNITED STATES OF AMERICA,
By _____ [L. S.]
Secretary of the Interior.

Witnesses:

_____ [L. S.]

APPLICATION FOR COAL-MINING LEASE.

The undersigned, _____,
a resident of _____,
a _____,

(Native born or naturalized; if the latter, furnish certificate.)

citizen of the United States, over 21 years of age, hereby applies, under the provisions of the act of October 20, 1914 (38 Stat., 741), for a mining lease of the certain leasing blocks, or tracts, of coal lands, to wit: Block _____, embracing the following specified legal subdivisions _____

aggregating _____ acres. If I secure said lease, I propose to invest not less than _____ dollars in active, productive mining operations conducted upon said lease; the active development will begin not later than _____. My experience in coal-mining operations is as follows: _____

I neither own nor hold any interest, either as a stockholder or other-

wise, in any lease under this act, or in any application for such a lease, save and except the application now made; and I hereby refer to

as to my financial standing.

If I am awarded a lease, I will supply a satisfactory bond as required in section 9 of the regulations.

My post-office address is

(Signed)

Subscribed and sworn to before me, a

....., on this day of

.. [SEAL.]

COAL-MINING PERMIT.

REGULATIONS GOVERNING THE ISSUANCE OF PERMITS FOR THE FREE USE OF COAL IN THE UNRESERVED PUBLIC LANDS IN ALASKA.

Section 10 of the act of October 20, 1914 (Public 216), provides:

That in order to provide for the supply of strictly local and domestic needs for fuel the Secretary of the Interior may, under such rules and regulations as he may prescribe in advance, issue to any applicant qualified under section three of this act a limited license or permit granting the right to prospect for, mine, and dispose of coal belonging to the United States on specified tracts not to exceed ten acres to any one person or association of persons in any one coal field for a period not exceeding ten years, on such conditions not inconsistent with this act as in his opinion will safeguard the public interest without payment of royalty for the coal mined or for the land occupied: *Provided*, That the acquisition of holding of a lease under the preceding sections of this act shall be no bar to the acquisition, holding, or operating under the limited license in this section permitted. And the holding of such license shall be no bar to the acquisition or holding of such a lease or interest therein.

Owing to there being no settlements or local industries in or adjacent to the Barrow or Melanuskuk coal fields, and the contemplated leasing offer of coal lands in said fields, these regulations and the permits provided for shall not at present apply to coal deposits in those fields.

Qualifications. Under the terms of the act, expressed in section 3 thereof, only citizens of the United States above the age of 21 years, associations of such citizens, corporations, and municipalities organized under the laws of the United States or of any State or Territory thereof, provided the majority of the stock of such corporations shall at all times be owned and held by citizens of the United States, are eligible to receive a permit to prospect for and mine coal from the unreserved public lands in Alaska.

Who may mine coal for sale. All permittees may mine coal for sale except railroads and common carriers, who by the terms of section 3 of the act are restricted to the acquirement of only such an amount of coal as may be required and used for their own consumption.

Duration of permits. Permits will be granted for two years, beginning at date of filing, if filed in person or by attorney, or date of mailing, if sent by registered letter, subject to the approval of the Commissioner of the General Land Office, and upon application and

satisfactory showing as to the necessity therefor, may be extended by the commissioner for a longer period, subject to such conditions necessary for the protection of the public interest as may be imposed prior to or at the time of the extension. Misrepresentation, carelessness, waste, injury to property, the charge of unreasonable prices for coal, or material violation of such rules and regulations governing operation as shall have been prescribed in advance of the issuance of a permit, will be deemed sufficient cause for revocation.

Limitation of area.—The act limits the area to be covered in any one permit to 10 acres. It is not to be inferred from this, however, that the permits granted thereunder shall necessarily cover that area. The ground covered by a permit must be square in form and should be limited to an area reasonably sufficient to supply the quantity of coal needed.

Scope of permit.—Permits issued under section 10 of the act of October 20, 1914, grant only a license to prospect for, mine, and remove coal free of charge from the unreserved public coal lands in Alaska, and do not authorize the mining of any other form of mineral deposit, nor the cutting or removal of timber.

How to proceed to obtain a permit.—The application should be duly executed on Form 4-020, and the same should either be transmitted by registered mail to, or filed in person with, the register and receiver of the United States land office of the district in which the land is situated. Prior to the execution of the application the applicant must have gone upon the land, plainly marked the boundaries thereof by substantial monuments, and posted a notice setting forth his intention of mining coal therefrom. The application must contain the statement that these requirements have been complied with and the description of the land as given in the application must correspond with the description as marked on the ground. The permit, if granted, should be recorded with the local mining district recorder, if the land is situated within an organized mining district.

When coal may be mined before issuance of a permit.—In view of the fact that by reason of long distances and limited means of transportation many applicants may be unable to appear in person at the United States land office to file their applications, it has been deemed advisable to allow such applicants the privilege of mining coal as soon as their applications have been duly executed and sent by registered mail to the proper United States land office. Should an application be rejected, upon receipt of notice thereof all privileges under this paragraph terminate and the applicant must cease mining the coal.

Action by register.—The register will keep a proper record of all applications received and all actions taken thereon in a book provided for that purpose. If there appear no reason why the application should not be allowed, the register will issue a permit on the form provided for that purpose. Should any objection appear either as to the qualifications of the applicant or applicants, or in the substance or sufficiency of the application, the register may reject the application or suspend it for correction or supplemental showing under the usual rules of procedure, subject to appeal to the Commissioner of the General Land Office. Upon the issuance of a permit the register will promptly forward to the Commissioner of the General Land Office, by special letter, the original application and a copy of the

permit, and transmit copies thereof to the Chief of the Alaskan Field Division, and to the local representatives of the United States Bureau of Mines, for their information.

NOTE: These regulations are intended merely as a temporary arrangement to meet immediate necessities, as authorized by section 10 of the act of October 20, 1914, and are not to be construed as applying to the leasing of public coal lands in Alaska provided in other sections of the act.

APPLICATION FOR COAL-MINING PERMIT.

....., 191

The Commissioner of the General Land Office,
Washington, D. C.

Sir: The undersigned,
(Name of applicant)

of
(Post office address), hereby apply for a permit to prospect for, mine, and remove coal from the following-described land:

(Describe the land by legal subdivision if surveyed, and by metes and bounds with reference to some permanent natural landmark if unsurveyed.)

containing approximately acres, situated within the land district, miles of
(Direction.)

Alaska, and in support of this application make the following representation as to qualifications to receive a permit:

(Citizenship of applicant or applicant must here be shown. If the applicant is a municipality or corporation, it must be shown under what laws it is organized, and if the latter, it must also be shown whether a majority of its stock is owned and held by citizens of the United States.)

The applicant further represent that
(He, they, or it) has not, within two years last past, applied for or received a permit to mine coal under the provisions of section 10 of the act of October 20, 1914, in the coal field in which the land described in this application is situated,
(State exception here, if any.)

and that the coal herein applied for is to be mined for the purpose of supplying the following demands, for which approximately tons are required annually:

(Here describe the various uses to which the coal is to be applied, stating the number of tons necessary for each use.)

It is further represented that the boundaries of the tract described in this application have been plainly marked by substantial monuments, and that a proper notice describing the land and showing the intention of the applicant to apply for a free permit to mine coal therefrom has been posted in a conspicuous place upon the land.

On consideration that a permit be granted, the applicant hereby agree :

1. To exercise reasonable diligence, precaution, and skill in the operation of the mine, with a view to the prevention of injury to workmen, waste of coal, damage to Government property, and to comply substantially with the instructions and the rules and regulations printed on the back of this application.

2. To charge only such prices for coal sold to others as represent a fair return for the labor expended and reasonable earning value to which the investment in the enterprise is entitled, without including any charge for the coal itself.

3. Not to mine or dispose of, either directly or indirectly, any coal from the area covered by said permit for export or any purpose other than "strictly local and domestic needs for fuel."

4. To leave the premises in good condition upon the termination of the permit, with all mine props and timbers in the mine intact, and with the underground workings free from refuse and in condition for continued mining operations.

Signature of applicant

The foregoing application was signed by

of, the applicant therein, in the presence of the undersigned, who, at request and in
(Hs or their.) (Hs or their.)
presence and in the presence of each other, have subscribed our names as witnesses to the execution thereof.

Dated this day of, 19 .., at
Territory of Alaska.

| | |
|------------|-----------------|
| Name | Residence |
| Name | Residence |

THE NENANA FIELD.

A complete topographic and subdivisional township survey has been made of the Nenana field, and a folio containing photolithographic copies of the approved township plats of such surveys may be procured on application to the Superintendent of Documents, Washington, D. C., for \$1.

In view of the fact that it was impossible for any kind of practicable transportation facilities to reach this field during the season of 1915, the field has not been examined by the expert mining engineers and geologists of the Interior Department with the view to dividing it into leasing blocks. This work will be done during the summer of 1916, whereupon, as promptly as possible, opportunity will be given for leasing in the Nenana field in accordance with the regulations herein provided. In the meantime temporary free coal-mining permits will be allowed under section 10 of the leasing act, operations under such permits to be subject, however, to future leases, as it is not deemed advisable to allow operations under such permits to interfere with the larger and more permanent operations contemplated under lease.

The Government railroad from Seward to Fairbanks will pass through the Nenana coal field. From the fields to Fairbanks is 110 miles.

PART 2. INFORMATION RELATING TO OPERATION AND DEVELOPMENT.

COMMENTS ON PROVISIONS OF THE LEASE.

An explanation of those articles and provisions of the lease form whose purposes may not be self-evident follows. It should be understood that this explanation is not in any sense either a part of the lease or agreement or a construction of its terms.

It will be observed that the Alaskan coal leasing act (38 Stat., 741) specifically states that—

The unreserved coal lands and coal deposits shall be divided by the Secretary of the Interior into leasing blocks or tracts of 40 acres each, or multiples thereof, and in such form as, in the opinion of the Secretary, will permit the most economical mining of the coal in such blocks, but in no case exceeding 2,560 acres in any one leasing block or tract.

In laying out the leasing blocks, or units, as described elsewhere in this report, it has been the endeavor to arrange each block so that the coal may be reached by drifts, tunnels, slopes, and shafts from adjacent valleys, or benches, and may be mined to the boundary of the lease by workings of reasonable length for underground haulage. In some cases, where the coal measures within a unit lie under high mountain ridges, it may be necessary to develop blocks by means of tunnels through adjacent leasing blocks.

In the case of some leasing blocks, particularly those in the Matanuska field, little is known about the coal measures that do not outcrop within the boundaries of the blocks, and prospecting will have to be done in some cases by drilling or by shafts. Manifestly many such leasing blocks will not be applied for immediately, but the presence of coal of workable thickness may be indicated subsequently by the developments on more accessible adjacent blocks.

ARTICLE 1, SECTION 1.

RIGHTS RESERVED BY LESSOR.

The lease plainly states that the lessor (represented by the Secretary of the Interior)—

Reserves unto itself the right to grant or use such easements in, over, through, or upon the land leased, entered, located, occupied, or used as may be necessary or appropriate to the working of the same or other coal lands by or under the authority of the Government and for other purposes * * *.

The purpose of this provision is to permit railroads, tramways, water lines, or other necessary means of transport and communication to be constructed and operated through blocks of land not reached by these means of transportation at the time these blocks were leased, and to enable leasing blocks or units not readily accessible on the surface to be reached by tunnels, slopes, or other openings driven through the blocks already leased. Whenever it is necessary to grant

arranged and located as to interfere in a minimum degree with mining operations on the blocks subject thereto. Wherever it seems advisable, jointly operated tunnels, slopes, or shafts for transportation and ventilation may be permitted, provided the conditions, limitations, penalties, and provisions contained in the act are observed. Whenever joint openings do not seem advisable, the openings for the operation of the subsequent leases will be required to be so driven as to interfere as little as may be with the operations of the prior lease or leases. Should there be material interference, the amount of damages to be paid to the prior lessee will be determined by a board of arbitrators, elsewhere referred to. (See art. 7, sec. 7.)

ARTICLE 3, SECTION 1.

MINING RIGHTS LIMITED TO COAL AND ASSOCIATED MINERALS.

Article 3 provides that—

The mining rights and privileges leased as aforesaid shall extend to and include only coal and associated minerals.

Article 8 (c) defines associated minerals as—

Fire clay, shale, sandstone, and the bedded materials of the coal measures, exclusive of gold-bearing or other metalliferous deposits.

Article 6, section 7, provides that the lessee—

Shall promptly notify the authorized representative of the lessor of the discovery of any valuable mineral or mineral substance other than coal * * * and shall not mine or remove same unless the same is an associated mineral.

The same section provides that—

Such quantities of fire clay, shale, or gas from the coal measures as may be required by the lessor in the conduct of operations hereunder may be removed and used without such written permission and without payment of royalty therefor.

Thus, if the lessee discovers any mineral other than the associated minerals named above he should promptly notify the authorized representative of the Secretary of the Interior; but he may take such fire clay, shale, or gas from the coal measures as he needs in his operations without paying royalty thereon. For example, fire clay may be taken out for use at boiler plants or shale for the making of brick used on the lease or inflammable gas (methane) liberated by mining operations may be trapped underground and piped to the surface for use in providing heat or light on the premises.

ARTICLE 4, SECTION 1.

INVESTMENT.

The underlying purpose of this section is to prevent the tying up of a valuable block for speculative purposes. The requirement should not be an obstacle to an operating company that intends to proceed vigorously and systematically in the development of a lease, for all the expenditures made in actual mining developments on the property that do not represent promotion expenses or interest charges will be considered as investments. The expenditures for actual mining developments include all legitimate charges for prospecting,

the driving of tunnels, drifts, entries, or slopes, or the sinking of shafts, and also the construction of tipples, houses for the use of employees, trestles, tramways, storehouses, barns, stables, reservoirs, railroad trucks, and all other work which may actually be essential in the opening and operation of a mine. Under these requirements it is expected, if the coal deposits prove to be workable, that at the end of the five-year period the mine or mines on the lease will, or should be, developed to a tonnage capacity permitting commercial operation. In brief, the requirement is intended to insure the proper development of the lease should the coal be of such thickness and quality and under such conditions as would justify continued operations on a commercial scale.

ARTICLE 4, SECTION 2.

ANNUAL RENT

The rental of 25 cents per acre the first year and 50 cents per acre for each of the remaining five years and \$1 per acre per year thereafter is an almost nominal charge if coal is produced in any considerable amount. For example: Suppose that the leasing block consisted of 1,000 acres. The charge for rental or advance royalty at the end of the first year would be only \$250, and on the basis of 2 cents per ton royalty on the coal this would call for a production of only 12,500 tons for the whole year, and from the second to the fifth year, to wipe out the fixed rental charge, it would require a production of only 25,000 tons annually. Even though no coal be mined, the total rental for the five years on 1,000 acres would be only \$2,250, and it is likely that the lease would have been surrendered long before the end of the five-year period if coal in commercial quantities was not being produced. On a lease of 1,000 acres of coal land an output of 400 tons per day would be a moderate output. If the mine worked 250 days in the year, it would produce 100,000 tons. If development showed that part of the land under lease did not contain workable coal, then that part of the lease in 40-acre tracts could be surrendered by the lessee and the gross annual rental, equivalent to the advance royalty, could be lessened.

ARTICLE 4, SECTION 3.

ROYALTY.

The lease provides for

* * * a royalty of 2 cents on every ton of 2,000 pounds of coal shipped or removed from the leased lands or manufactured into coke, briquettes, or other products of coal, or consumed on the premises, during the first five years succeeding the execution of this lease. * * *

The royalty for the opening period is made low in order to encourage the development of coal mines. A royalty of 5 cents per ton after the mine or mines on the lease have been opened up is also low in comparison with the size of royalty required in many coal fields of the United States. Except for some extremely low royalties in the middle West, the range is from 10 cents to 25 cents per ton. In the State of Washington, which is more directly competitive with Alaska, the royalties range from 15 to 25 cents per ton.

ARTICLE 6, SECTION 4.

FIFTY-FOOT BARRIER PILLARS AT THE BOUNDARY LINES.

The safety of the miners, as well as the property, demands that large barrier pillars be left between adjacent leases until the removal of the pillars by one or the other of the lessees becomes safe and expedient. The provision that the barrier pillar shall not be extracted until water that may have accumulated in adjoining abandoned workings has been lowered can in most cases be complied with, after permission has been obtained, by drilling holes through the pillar and drawing off the water in accordance with the methods followed in safe mining practice.

ARTICLE 6, SECTION 5.

LIMITATIONS OF COAL TO BE EXCAVATED IN ADVANCE WORKINGS UNDER ROOM-AND-PILLAR SYSTEM.

Under the "room and pillar," or any other method of mining that requires pillars of solid coal for the support of the overlying strata, the pillars must be large enough to furnish adequate support. In some parts of the United States it has been the practice to take so much coal in the advance workings as to bring undue strain on the pillars, roof, or floor, with resulting fracture of the roof, crushing of pillars, or squeezing up of the floor, endangering life and causing serious losses of coal. A "squeeze" in any mine is a grave reflection on the method of operation followed, yet "squeezes" are found in many coal-mining districts.

The percentages of extraction permitted for advance workings apply to different depths below the surface; they represent the maximum amount of extraction that should be permitted, and by no means represent the best practice, except the 20 per cent specified for more than 1,750 feet of depth. Many mines in the Connellsville, Pa., district having less than 600 feet of vertical depth of cover extract only 20 per cent of the coal by advance workings. The very best practice is to mine out all the coal by the long-wall method and use waste rock to stow or pack the excavations behind the face.

The provision that—

The said coal areas shall mean an area parallel with the dip or rise of the coal bed. The percentages of coal to be mined in the areas comprised in the advance workings as compared with the percentages of coal to be left standing in such workings * * *

means that the area of the pillars is not to be calculated on the basis of a horizontal plane, but in the plane of the coal bed itself. The further provision that the percentage of coal to be left standing

* * * shall not be construed to mean the percentage of the total amount of the coal in any such area of any such bed, where such bed in such area is thicker than the height of any such workings * * *

means that the percentages of the areas must be considered and not the percentages of total coal. Obviously there is no difference between the two when the coal bed is not thicker than the height

of the excavated drifts, levels, gangways, rooms, or chambers, but if a room should be excavated to a height, say, of 8 feet when the coal bed is 10 or 20 feet thick, the thickness of the coal left up as a roof should be disregarded in figuring the strength of the pillars to resist crushing. The section also provides:

* * * nor shall such percentages of areas be held to include the coal extracted from the pillars in any such area, panel, or district of the mine, as it is the intent of the parties hereto that, save as otherwise provided in this lease, and except where the retention of pillars shall be necessary for the maintenance of main roads or passageways or for the protection of the property, all such pillars shall be mined and removed as rapidly as proper mining will permit.

It is not the intent to prevent the withdrawal of the pillars when the rooms or chambers are driven to their proper distances, if no pillars in overlying beds would be affected by such withdrawal.

ARTICLE 6, SECTION 6.

FIRES IN MINE PROHIBITED.

To reduce the danger to life and the possible loss of coal by fires, it is provided that the lessee

shall not, save as hereinafter authorized, light, keep or maintain any fire in any mine or stopping, except as approved by the authorized representative of the lessor, or underground in any mine, or in contact with the coal in place or in or along the outcrop of any coal bed.

This provision is to prevent the starting of fires for heating purposes where they might cause a serious fire in the mine or coal bed. Fires of this origin were formerly frequent in certain coal districts of the United States. An exception that is permitted, subject to the approval of the authorized representative, is the use of a ventilating furnace as a temporary ventilating expedient. Such furnaces, however, are to be constructed or arranged in accordance with the specifications of article 13.

ARTICLE 6, SECTION 9.

SECOND EXIT TO SURFACE TO BE PROVIDED WHERE MORE THAN TEN MEN ARE EMPLOYED ON A SHIFT.

To provide for the escape of men in the event of an explosion or fire, the lessee must

* * * where more than ten men are employed underground on any one shift in any separate mine, provide an escape way or second exit to the surface which shall be separated at the surface from the first exit by not less than 50 feet of strata in case of drift, slope, or tunnel workings, or in case of vertical shafts, or of inclined shafts having a pitch of more than 45 degrees, by not less than 200 feet of strata.

The specified distances between the openings are not recommended, but must be regarded as the minimum distances permissible. The less the pillar between the mainway or escapeway and the haulage way is broken by crosscuts the better the protection afforded in case of fire or explosion. All such crosscuts, if not in active use, should have strong fireproof stoppings; if in active use, they should have emergency doors of fireproof material which may be closed in time of accident.

This section permits an alternative arrangement for an escapeway, as follows:

* * * An escapeway or outlet through an adjoining mine shall be regarded as a sufficient compliance with this requirement if kept at all times in proper condition for use.

It is not considered the best practice to provide an escapeway through an adjoining mine that is active and employs 10 or more men, as an explosion or fire in one mine endangers the safety of the lives of the men in the other. A far better plan is to have separate exits for separate mines. However, where coal measures are so complicated as in some of the Alaskan coal fields, conditions may arise under which a second exit through an adjoining active mine is the best arrangement that can be provided promptly; but such an escapeway should have emergency doors and "explosion barriers," so that a fire or explosion in either mine may not endanger the lives of men in the other.

ARTICLE 6, SECTION 11

NO BUILDING OF INFLAMMABLE MATERIAL TO BE CONSTRUCTED WITHIN 75 FEET OF ANY MINE.

This section provides that the lessee

shall not construct or maintain any structure of inflammable material within 75 feet of any mine opening; nor within said distance permit any structure of noninflammable material to be connected to any other structure by means of any structure or erection of inflammable material, or to be connected to any structure beyond said distance which shall be constructed of inflammable material, except as follows: that to wit:

(a) An open-timber framework, or head frame of timber may be constructed over a shaft, slope, or incline.

(b) The posts, studs, and rafters of any such structure may be of wood if the covering or lining is made of noninflammable material, but under no circumstances shall wood flooring be used, except in tippie and trestle structures.

Under these terms surface buildings that by burning may carry fire into the mine with disastrous results are not permitted. The engine house and other buildings should have a floor of concrete, cement, or packed dirt. Under the stated provisions the main timbers of a head frame, or the posts, studs, and rafters of a covered passage may be of wood, but either the framework must be left open or the cover or lining must be of noninflammable material, such as galvanized or painted corrugated iron or steel, or cement or plaster based on wire mesh. It is much better practice to fireproof even the frame, if of wood, with a coating of cement or plaster on a reinforcement of wire mesh, or, better still, to make these members of steel.

ARTICLE 6, SECTION 12.

MAIN INTAKE AND RETURN AIRWAYS TO BE SEPARATED BY NOT LESS THAN 50 FEET OF NATURAL STRATA.

This section provides that the lessee

except in a prospect opening, shall separate the main intake and return airways and all workings parallel to such airways by not less than 50 feet of strata.

Pillars of such size between the main intake and return airways are provided in ordinary mine layouts, and in many parts of the United States the main pillars are made thicker or wider than 50 feet.

The provision insures an adequate separating pillar between the adjacent parallel entries and thus lessens the hazard from falls of roof and increases the protection in case of explosion or fire.

ARTICLE 6, SECTION 13.

FAN NOT TO BE PLACED IN DIRECT LINE WITH ANY MINE ENTRANCE.

This section treats of a ventilating fan and among other things provides that

* * * the fence shall not set same in line with the axis of any mine opening but shall place same at a distance of not less than fifteen feet from the projection of the nearest side of such opening, and shall provide explosion doors of the full area of the shaft or airway, in direct line with any and all such mine openings in order to protect said fan or other mechanical means of air circulation in case of a mine explosion * * *

At many coal mines fans set in line with the main entrance have been demolished by the blast of an explosion, damaged beyond the possibility of repair, or so badly damaged as to cause serious delay. Offsetting the fan protects it and permits prompt renewal of the ventilating currents, so that men may be rescued who otherwise would be suffocated.

INFORMATION ON COAL LANDS AND THEIR DEVELOPMENT.

OCCURRENCE AND QUALITY OF ALASKAN COALS.

The known areas of coal-bearing rocks¹ of Alaska according to the Geological Survey include about 10,000 square miles (12,240,000 acres), and of this 1,310 square miles (774,400 acres) is pretty definitely known to be underlain by coal beds. The rest of the fields have not yet been surveyed in sufficient detail to permit of definite statement of the percentage of actual coal lands. About 12 per cent of the total known coal lands are anthracite, semianthracite, semibituminous, and bituminous coal, the balance being subbituminous and lignitic.

The most important fields are the Bering River, including about 50 square miles (32,000 acres) of coal lands, and the Matanuska, including about 100 square miles (64,000 acres) of coal lands. Both these fields contain high-grade bituminous and anthracite coals and both include coking coals. Some of the coal beds in both fields have been so crushed as seriously to detract from their value, if not to render them worthless, but workable beds undoubtedly exist in both fields. There is some high-grade bituminous coal near Cape Ishurno, on the Arctic seaboard, but this is too inaccessible to enter into the present fuel situation.

Subbituminous coals have been found on the Alaska Peninsula and also in northwestern Alaska. Those on the Alaska Peninsula have value for local use, but are not high enough grade to warrant export.

Lignitic coal finds a very wide distribution in Alaska. The largest of the known areas are those of the west side of the Kenai Peninsula and the Nemuna field, located on the south side of the

¹ The term "coal bearing rocks" is here used to indicate formations which at one place or another carry coal. It does not imply that the entire area is underlain by coal.

Tanana Valley and about 50 miles from Fairbanks. This lignitic coal has value for local use, but is not of a sufficiently high grade to warrant its export.

GEOLOGIC DISTRIBUTION OF COAL.

The oldest coals known in Alaska are some which are of a high-grade bituminous character and occur near and south of Cape Lisburne, on the Arctic Ocean. These are contained in a formation of Mississippian (lower Carboniferous) age, made up of slates and limestones. On the upper Yukon is a series of conglomerates, and dunes, and shales (Nation River formation) which carries some thin beds of bituminous coals. This formation is Carboniferous and has been provisionally assigned to the Mississippian epoch. The next higher coal-bearing beds are in the Corwin formation, which occurs about 20 miles east of Cape Lisburne. This formation is made up of shales, sandstones, and conglomerates and includes a large number of beds of subbituminous coal. It has been referred to the Jurassic period. A coal-bearing formation of about the same age has been recognized in the Matanuska Valley, northeast of Cook Inlet, but no Jurassic coals are known elsewhere in Alaska. Upper Cretaceous coals have been found in southeastern Alaska, on the Alaska Peninsula, on the lower Yukon, and in the Colville River basin. Except in southeastern Alaska, where only lignite has been found, the Cretaceous coals are chiefly bituminous. Lithologically the Upper Cretaceous rocks vary in different localities, but as a rule they are composed predominantly of the finer elastic material and limestone.

The Kenai formation (Eocene) is by far the most important of the coal measures. It has been found in large and small areas almost throughout Alaska and nearly everywhere carries some coal. It is typically made up of coarse and fine elastic material, locally with a large percentage of conglomerate. Much of the Kenai can be definitely recognized as of fluvial origin, and in many places it carries a fresh-water flora. Only on the Alaska Peninsula have marine fossils been found in the formation, and here they are intimately intermingled with plant remains. Much the larger part of the Kenai coal is lignitic, but the high grade coal of the Matanuska field and possibly part of that of the Bering River field are also of Kenai age. The Bering River coal may be in part of Miocene age; if so, it is the only Miocene coal recognized in Alaska. Some thin beds of lignitic coal that have been found at Yakutat Bay and at various places in the Yukon basin are probably of Pliocene, possibly of Pleistocene, age.

The geologic positions of the Alaska coals are summarized in the subjoined table:

¹ Brooks, A. H., and others, Mineral resources of Alaska, report on progress of investigations in 1901 (Bull. 112, U. S. Geol. Survey, 1902, pp. 47-50).

Stratigraphic position of Alaska coals

| System | Series | Character of coal | Principal distribution |
|----------------|------------------------|--|---|
| Quaternary... | Pleistocene..... | Lignite | Yukon Basin and other parts of Alaska. |
| | Pliocene..... | do..... | Yukon Bay and other localities, Bering River. |
| | Miocene or Eocene..... | Anthracite and bituminous | Throughout Alaska, notably on Cook Inlet and in Matanuska Valley, Seward Valley, and Yukon Basin. |
| Tertiary..... | Pliocene..... | Chiefly lignite; also some bituminous and subbituminous. | |
| Cretaceous.... | Upper Cretaceous .. | Subbituminous and bituminous. | Alaska Peninsula, Yukon and Colville Basins. |
| Jurassic .. | ..... | do..... | New Cape Lisburne. |
| Carboniferous. | Mississippian .. | Subbituminous..... Bituminous | Yukon River, 20 miles south of Cape Lisburne. |

COMPOSITION OF COAL.

The following table summarizes the composition of the Alaskan coals:

Analysis of Alaska coals.¹

| Series, bed and kind of coal. | Moisture. | Volatile matter. | Fixed carbon. | Ash. | Sulfur. |
|---|-----------|------------------|---------------|-------|---------|
| ANTRACITE | | | | | |
| Bering River, average of 7 samples..... | 7.84 | 6.45 | 78.24 | 7.71 | 1.30 |
| Matanuska River, 1 sample..... | 9.55 | 7.04 | 81.32 | 6.65 | .57 |
| SUB-BITUMINOUS | | | | | |
| Bering River, average of 11 samples..... | 6.10 | 8.87 | 76.60 | 9.27 | 1.04 |
| SUB-BITUMINOUS | | | | | |
| Bering River, coking coal, average of 2 samples..... | 1.48 | 14.63 | 72.32 | 9.30 | 1.74 |
| Cape Lisburne, average of 3 samples..... | 3.00 | 17.47 | 75.95 | 2.92 | .90 |
| Matanuska River, coking coal, average of 3 samples..... | 2.71 | 20.24 | 65.30 | 11.60 | .57 |
| BITUMINOUS | | | | | |
| Lower Yukon, average of 11 samples..... | 4.04 | 31.14 | 60.62 | 7.50 | .48 |
| SUB-BITUMINOUS | | | | | |
| Matanuska River, average of 3 samples..... | 0.50 | 35.41 | 49.11 | 8.57 | .37 |
| Chignik Bay, Alaska Peninsula, average of 3 samples..... | 0.98 | 30.80 | 42.88 | 10.26 | 1.50 |
| Horendeen Bay, Alaska Peninsula, average of 2 samples..... | 7.75 | 32.61 | 50.00 | 9.20 | .30 |
| Natton River, Yukon Basin, 1 sample..... | 1.39 | 40.62 | 55.55 | 3.01 | 2.08 |
| Koyukuk River, 1 sample..... | 4.47 | 31.34 | 48.20 | 12.95 | ... |
| Cape Lisburne, average of 11 samples..... | 0.35 | 38.61 | 47.19 | 5.45 | .35 |
| Anaktuvuk River, 1 sample..... | 0.35 | 30.30 | 45.38 | 13.38 | .51 |
| LIGNITE | | | | | |
| Admiralty Island, north of Alaska, average of 5 samples..... | 1.97 | 37.31 | 35.18 | 24.24 | .57 |
| Port Graham, Cook Inlet, average of 2 samples..... | 19.41 | 38.10 | 35.70 | 7.60 | .30 |
| Kachemak Bay, Cook Inlet, average of 3 samples..... | 20.40 | 38.77 | 35.55 | 10.25 | .35 |
| Tyonek and Beluga Rivers, Cook Inlet, average of 3 samples..... | 21.50 | 37.28 | 30.00 | 10.04 | .57 |
| Unga Island, Alaska Peninsula region, average of 4 samples..... | 10.09 | 30.30 | 20.81 | 16.83 | .91 |
| Kodiak Island, 1 sample..... | 12.41 | 31.18 | 31.80 | 2.41 | .17 |
| Chitstoshon River, Copper River Basin, 1 sample..... | 15.01 | 40.35 | 10.16 | 4.28 | ... |
| Chitstoshon River, Copper River Basin, 1 sample..... | 1.05 | 51.70 | 40.75 | 6.10 | ... |
| Upper Yukon, Chitstoshon, average of 3 samples..... | 15.04 | 30.38 | 30.24 | 7.72 | 1.20 |
| Upper Yukon, Chitstoshon, average of 3 samples..... | 10.45 | 41.81 | 40.49 | 7.37 | 1.30 |
| Upper Yukon, Ratayuk, 1 sample, average of 3 samples..... | 11.42 | 41.15 | 36.95 | 10.48 | .33 |
| Nonana River, Tanana River Basin, 1 sample..... | 14.02 | 48.81 | 32.40 | 5.77 | .10 |
| Chicago Creek, Seward Peninsula, average of 3 samples..... | 37.71 | 22.11 | 22.27 | 8.80 | ... |
| Wainwright Inlet, Seward Peninsula, 1 sample..... | 40.05 | 42.09 | 20.04 | 3.42 | .02 |
| Colville River, north of Alaska, 1 sample..... | 11.50 | 30.31 | 30.27 | 27.00 | .50 |

¹U. S. Geol. Survey Bull. 112, pp. 30-50.

GOVERNMENT PUBLICATIONS RELATING TO ALASKA COAL FIELDS.

- *Atwood, W. W. Geology and mineral resources of part of the Alaska Peninsula, Bull. 167, U. S. Geol. Survey, 1911, 136 pp. Describes the Herodotus Bay, Chignik Bay, and Unga Island fields, and is accompanied by topographic and geologic reconnaissance maps.
- *Brooks, A. H. Mineral resources of Alaska, Alaska coal and its utilization. Bull. 442, U. S. Geol. Survey, 1910, pp. 1-100. Describes briefly the coal fields of Alaska.
- {Brooks, A. H. The Circle precinct. Bull. 314, U. S. Geol. Survey, 1907, 235 pp. Describes the coal of Washington Creek on upper Yukon. 30 cents.
- {Brooks, A. H. The Alaskan mining industry in 1913. Bull. 592, U. S. Geol. Survey, 1914, pp. 43-74. Describes an occurrence of coal near Iditarod. 60 cents.
- *Capps, S. R. The Bonnichfield region. Bull. 504, U. S. Geol. Survey, 1909, 64 pp. Describes the Nenana coal field and is accompanied by geologic and topographic reconnaissance maps.
- {Collier, A. J. Geology and coal resources of the Cape Lisburne region. Bull. 278, U. S. Geol. Survey, 1906, 54 pp. Describes the Colwin and Cape Lisburne coal fields. Accompanied by geologic reconnaissance map. 40 cents.
- *Collier, A. J. The coal resources of the Yukon. Bull. 218, U. S. Geol. Survey, 1903, 74 pp. Describes the coals of the Yukon River and is accompanied by geologic reconnaissance map.
- {Fieldner, A. O., and others. Analyses of mine and can samples of coal collected in the fiscal years 1911 to 1913. Bull. 36, Bureau of Mines, 1914, pp. 19-23, 151-163. Gives analyses of samples and describes coal beds sampled.
- {Fisher, W. L. Alaskan coal problems. Bull. 36, Bureau of Mines, 1914, 32 pp. Summarizes information regarding the areal extent of Alaskan coal fields, the quality of the coal, its suitability for various purposes, and the probable market for it.
- {Henshaw, F. F. Mining in the Fairhaven district. Bull. 379, U. S. Geol. Survey, 1909, pp. 355-369. Describes the Chicago Creek coal mine. 60 cents.
- {Lord, N. W., and others. Analyses of coals in the United States, with descriptions of mine and field samples collected between July 1, 1904, and June 30, 1910. Bull. 22, Bureau of Mines, 1912, pp. 41-46, 345-378. 85 cents. Gives analyses of samples and describes coal beds sampled.
- {Maddren, A. G. Mineral deposits of the Yakutat district. Bull. 502, U. S. Geol. Survey, 1914, pp. 149-163. Describes the Yakutat coal field and is accompanied by economic and reconnaissance map. 60 cents.
- {Martin, G. C. Geology and mineral resources of the Controller Bay region, Alaska. Bull. 335, U. S. Geol. Survey, 1908, 141 pp. Describes the Bereng River coal field and includes detailed geologic, economic, and topographic maps. 70 cents.
- *Martin, G. C., Johnson, B. L., and Grant, C. S. Geology and mineral resources of Kotzebue Peninsula. Bull. 587, U. S. Geol. Survey, 1915, pp. 101-140. Describes the Kachemak Bay coal field of Cook Inlet and is accompanied by geologic and topographic reconnaissance maps.
- *Martin, G. C., and Katz, F. J. Geology and coal fields of the lower Matanuska Valley, Alaska. Bull. 500, U. S. Geol. Survey, 1912, 98 pp. Describes the coal fields of the lower Matanuska Valley, including the Chickadee area. Report includes detailed geologic, economic, and topographic maps.
- {Martin, G. C., and Mortie, J. B., jr. Mineral resources of the upper Matanuska and Nelchina Valleys. Bull. 592, U. S. Geol. Survey, 1914, pp. 224-239. Describes the coal fields of the upper Matanuska Valley. Accompanied by a small scale economic map. 60 cents.
- *Moffitt, F. H. The Fairhaven gold placers, Seward Peninsula. Bull. 242, U. S. Geol. Survey, 1905, p. 67. Describes the occurrence of coal at Chicago Creek. Accompanied by geologic and topographic reconnaissance maps.
- {Schneider, P. C. A reconnaissance in northern Alaska across the Rocky Mountains, along Koyukuk, John, Amuktyuk, and Colville Rivers, and the Arctic coast to Cape Lisburne, in 1901, with notes by W. J. Peters. Prof. Paper 29, U. S. Geol. Survey, 1904, 139 pp. Describes the occurrence of coal in the Colville Valley. 40 cents. Accompanied by geologic and topographic reconnaissance maps.

* May be obtained from the Director of the U. S. Geological Survey, Washington, D. C.

{ May be purchased from Superintendent of Documents, Government Printing Office, Washington, D. C., at price given.

† May be obtained from the Director of the Bureau of Mines, Washington, D. C.

- *Smith, P. S. The Noatak Kobuk region. Bull. 536, U. S. Geol. Survey, 1913, 160 pp. Describes the occurrence of coal in the Kobuk Valley. Accompanied by geologic and topographic reconnaissance maps.
- *Smith, P. S., and Eakin, H. M. A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay Nadlat region. Bull. 449, U. S. Geol. Survey, 1911, 146 pp. Describes the coal deposits of Norton Bay region and is accompanied by geologic and topographic reconnaissance maps.
- [Wright, C. W. A reconnaissance of Admiralty Island. Bull. 287, U. S. Geol. Survey, 1906, pp. 144-146, 151-154. Describes the Knutznahee Inlet coal field on Admiralty Island. Accompanied by geologic reconnaissance map. 75 cents.
- Report by Secretary of the Navy on Coal in Alaska for Use in United States Navy. H. R. Doc. No. 376, 63d Cong., 2d sess., 1911, 123 pp.
- Report by Secretary of the Navy on Experimental Tests of Matanuska Coal for Naval Ships. S. Doc. No. 26, 61th Cong., 1st sess., 1910, 76 pp.

DESCRIPTION OF THE BERING RIVER COAL FIELD.

GEOGRAPHY.

The coal-bearing areas in the Bering River field are embraced in T. 16 S., Rs. 8 and 9 E.; T. 17 S., Rs. 6, 7, 8, and 9 E.; and T. 18 S., Rs. 6 and 7 E., of the Copper River base and meridian.

The country in general is rough and broken and is traversed by many streams, the principal of which is Bering River. This glacial stream rises in the Berg Lakes on the margin of Bering Glacier and flows south, thence west, thence southwest past the outlet of Bering Lake, and empties into Controller Bay. Icebergs sometimes jam at the source of this river and dam the water in the Berg Lakes. When these ice jams break, the flood of impounded water sometimes rushes down the Bering River Valley, overflowing the banks of the stream, which ordinarily is very shallow and can be navigated only by flat-bottom boats of light draft.

Other important streams of this field are Stillwater, Canyon, Shepherd, and Dick Creeks.

ACCESSIBILITY.

The Bering River coal field is situated about 35 miles east of Copper River and extends more than 30 miles east into the snow and glacier capped Chugach Mountains. From Katalla one can reach the coal field by wagon through Katalla Pass, or by launch, which is the customary way, around by Strawberry Harbor, through the channel north of Kannik Island, thence to the mouth of Bering River, and up the river to the lake. From the lake one can go by a small launch for some distance up Shepherd Creek and then by trail to the Kushlaka or Lake Charlotte areas. One can also go by small launch or skiff up Bering River to Stillwater Creek and from that point by trail to the various parts of the eastern end of the field.

CLIMATE.

This coal field is not far from the Pacific coast, and as a result has an unusual amount of rain, which is characteristic of the coast region of Alaska. The estimated rainfall is about 200 inches annually. The winters are fairly moderate, with more clear days, perhaps, than during the summer.

* May be obtained from the Director of the U. S. Geological Survey, Washington, D. C.

† May be purchased from Paper-entirement of Documents, Government Printing Office, Washington, D. C., at price given.

TRANSPORTATION FROM THE BERING RIVER COAL FIELD

There are several possible outlets from the Bering River field. One is by building a railroad to Controller Bay and establishing a shipping point on Okaleo Channel north of Okaleo Spit. A line from this point would run in a northerly direction to a crossing of the Bering River, near the mouth of Stillwater Creek, a distance of 20 miles; thence following up Stillwater Creek to Kushtaka Lake and following along the north shore of the lake, passing in front of Kushtaka glacier to Shepherd Creek and up Shepherd Creek to about the center of the coal deposits on that creek, the distance from Bering River crossing being about 12½ miles. Short spurs could be run up Canyon Creek, Clear Creek, Trout Creek, and Carbon Creek to reach the deposits. Should it be desired to reach the deposits on Shepherd Creek by a more direct route, a branch would leave the line above described about 15 miles from Okaleo Channel and run in a northwesterly direction directly across to the point of the Kushtaka Ridge, and thence up Shepherd Creek. This line would be about 8 mile shorter, but would not reach the coal deposits on Canyon Creek, Clear Creek, or Trout Creek.

A second possible route is by a railroad built from Katalla Junction on the Copper River & Northwestern Railroad. Katalla Junction is about 38 miles from Cordova. From this junction to the point on Shepherd Creek noted heretofore would be approximately 27 miles; thence to reach the other coal deposits it would be necessary to build the 12½ miles around Kushtaka Lake and down Stillwater Creek to Bering River with the necessary spurs.

COALS OF THE BERING RIVER FIELD.¹

The coal beds of the Bering River field are in rocks of Tertiary age known as the Kushtaka formation, which is composed of arkose, shale, and sandstone and has an aggregate thickness of about 2,500 feet. The coal-bearing rocks have been intensely folded and much faulted, but are not cut by intrusive rocks to any considerable extent. The structure is most complex in the eastern part of the field where the rocks are closely folded. In the western part of the field the folding is of a more open type, the pressure seemingly having been relieved to some extent by faulting.

The extent of the Kushtaka formation in the area that has been mapped in detail is about 44 square miles, of which 15.5 square miles is in the area of the high-grade semibituminous coal, about 7 square miles is in the area of the semianthracite coal, and 22.5 square miles is in the area of the anthracite coal. An additional area of 38.7 square miles is possibly underlain by the Kushtaka formation at greater or less depth, but overlying rocks, gravels, and glaciers cause considerable uncertainty as to its precise position, if not as to its actual presence.

The workable coal beds in this field are 3 to 25 feet thick, but through local swellings the maximum thickness is much greater. In quality the coals range from anthracite to semibituminous. (See analyses, pp. 47, 48.) The field probably includes some coking coals.

¹ Martin, G. G., *Geology and mineral resources of the Controller Bay region, Alaska*. U. S. Geol. Survey Bull. 335, 1908, pp. 65-133, and Pl. VIII.

Excessive deformation of the strata has led to the crushing of much of the coal, especially the anthracite and semianthracite. These occur in the eastern or more closely folded part of the field, and because of their crushed condition are of uncertain value.¹

The coal bearing rocks of the Bering River field trend to the north-east into the un-eroded high ranges, where it is probable that there may be other extensive areas, but it should be noted that, on account of the expense of development, any coal in the high ranges is not likely to be made available until the more accessible fields approach exhaustion or until coal commands a much higher price than it does now.

The Tokum formation, which overlies the Kushtaka, contains no coal, nor does the Stillwater formation, which underlies the Kushtaka.

The composition and heating value of the coal are shown in the following table:

Analyses and tests of Bering River coals.

[Analytical methods of coal as received.]

ANTHRACITE.

| Sample No. | Labo- ratory No. | Composition, as analyzed. | | | | | | Calorific value | | Fuel value. |
|------------|------------------------|---------------------------------|-------------------|--|-------------------------------|-------------------|----------------------------------|---------------------------|---|----------------|
| | | Loss on drying, per cent. | Total moisture | Volatile com- bustible, per cent. | Fixed carbon, per cent. | Ash, per cent. | Hyd- ro- gen, per cent. | Calo- ries, per lb. | British thermal units, per lb. | |
| 2 | 2165 | 1.50 | 7.67 | 5.78 | 60.01 | 20.62 | 2.90 | | | 11.42 |
| 3 | 2165 | 1.50 | 7.71 | 5.41 | 55.91 | 4.03 | 1.10 | | | 15.88 |
| 5 | 2180 | 0.10 | 0.30 | 8.00 | 87.00 | 3.41 | 1.11 | | | 12.80 |
| 6 | 2181 | 11.70 | 11.50 | 5.01 | 71.87 | 7.74 | 8.1 | 6,743 | 19,147 | 14.75 |
| 7 | 2184 | 0.50 | 7.50 | 0.04 | 75.89 | 10.21 | 1.97 | | | 11.43 |
| 8 | 2190 | 5.50 | 5.91 | 0.50 | 81.47 | 5.81 | 8.0 | | | 12.05 |
| 9 | 2164 | 7.00 | 9.31 | 7.19 | 87.43 | 2.44 | 1.05 | | | 11.58 |
| Average | | | 7.88 | 0.46 | 78.73 | 7.74 | 1.30 | | | 12.86 |

SEMANTHRACITE.

| | | | | | | | | | | |
|-----------------|------|------|------|-------|-------|-------|------|-------|--------|-------|
| 10 | 2181 | 5.00 | 7.04 | 0.20 | 78.53 | 4.34 | .70 | | | 8.54 |
| 11 | 2169 | 1.50 | 1.44 | 10.44 | 80.78 | 1.65 | .61 | 7,568 | | 7.07 |
| 14 | 1101 | 0.00 | 7.77 | 7.40 | 75.59 | 0.71 | .60 | 6,984 | 12,560 | 10.24 |
| 16 | 1103 | 0.20 | 7.44 | 0.80 | 71.35 | 14.30 | .67 | 6,006 | 11,801 | 10.40 |
| 17 | | | 3.74 | 0.70 | 67.07 | 24.00 | 1.04 | 6,592 | | 6.43 |
| 19 | 4104 | 5.30 | 7.04 | 0.87 | 76.31 | 6.74 | .57 | 7,955 | 13,050 | 7.77 |
| 20 | 1160 | 1.80 | 2.05 | 0.81 | 75.74 | 11.50 | 1.08 | 7,401 | 12,781 | 11.12 |
| 21 ² | | | 1.11 | 0.30 | 81.57 | 7.70 | .77 | | | 13.43 |
| 24 | 1141 | 5.00 | 5.74 | 0.55 | 80.89 | 4.05 | 1.22 | 7,881 | 14,180 | 9.24 |
| 26 | 1153 | 3.00 | 4.40 | 0.74 | 94.60 | 2.50 | 1.47 | 8,001 | 14,564 | 9.71 |
| 27 | 1160 | 5.50 | 0.50 | 0.71 | 71.54 | 17.67 | .60 | 6,800 | 12,448 | 7.77 |
| 28 | 1160 | 1.80 | 5.80 | 10.56 | 78.41 | 4.81 | 2.50 | 7,550 | 19,570 | 7.22 |
| Average | | | 0.40 | 0.67 | 76.10 | 9.27 | 1.08 | | | 8.77 |

¹ Report on coal in Alaska for use in United States Navy, H. R. Doc. No. 876, 64d Cong., 2d sess., 1914, 121 pp.

² Correspond with number on the map of the Bering River coal field (in pocket). Samples 2 to 81 were taken by the United States Geological Survey in 1904-1906; samples 84 to 92, by the Bureau of Mines in 1915. Locations of the beds from which the samples were taken are given on pages 48 to 55. No analyses are available of samples from points 1 to 92 except the given in this table.

³ Sample of natural coke.

Analyses and tests of Bering River coals. Continued

SEMIBITUMINOUS.

| Sample No. | Laboratory No. | Proximate analysis | | | | | | Calorific value | | Fuel ratio |
|------------|----------------|----------------------|-----------------|------------------------|---------------|-------|-----------|-----------------|-----------------------|------------|
| | | Loss on air-dry-ing. | Total moisture. | Volatile com-bustible. | Fixed carbon. | Ash. | Sul-phur. | Cal ories. | British thermal unit. | |
| 29 | 4151 | 9.40 | 3.60 | 43.47 | 57.40 | 0.04 | 1.05 | 11,114 | 11,114 | 5.85 |
| 33 | 2480 | 1.30 | 2.14 | 46.58 | 50.68 | 1.63 | 1.15 | 11,114 | 11,114 | 4.84 |
| 34 | | | 2.36 | 48.13 | 41.87 | 1.00 | 1.1 | 11,114 | 11,114 | 4.97 |
| 36 | 2481 | 5.40 | 6.31 | 44.70 | 60.53 | 0.85 | 0.4 | 11,114 | 11,114 | 4.9 |
| 43 | 4128 | 8.60 | 0.36 | 47.09 | 44.01 | 3.68 | 0.4 | 11,114 | 11,114 | 5.40 |
| 44 | 4155 | 3.80 | 5.14 | 44.19 | 50.05 | 1.80 | 0.5 | 11,114 | 11,114 | 6.07 |
| 480 | 2497 | 1.90 | 2.68 | 44.06 | 51.41 | 1.90 | 1.2 | 11,114 | 11,114 | 6.61 |
| 480 | 4163 | 1.30 | 2.09 | 40.74 | 51.13 | 1.07 | 1.11 | 11,114 | 11,114 | 6.61 |
| 550 | 2486 | 3.00 | 4.24 | 44.04 | 50.75 | 1.09 | 0.6 | 11,114 | 11,114 | 5.68 |
| 550 | | | 5.50 | 46.61 | 48.41 | 1.11 | 1.2 | 11,114 | 11,114 | 5.61 |
| 550 | 2495 | 4.00 | 5.69 | 44.04 | 46.81 | 3.85 | 1.2 | 11,114 | 11,114 | 5.61 |
| 550 | | | 1.20 | 47.98 | 57.60 | 3.85 | 1.2 | 11,114 | 11,114 | 4.49 |
| 58 | 2494 | 3.90 | 1.91 | 45.31 | 57.29 | 1.11 | 1.1 | 11,114 | 11,114 | 6.00 |
| 60 | 4153 | 3.20 | 4.01 | 49.46 | 57.47 | 0.60 | 1.14 | 11,114 | 11,114 | 6.24 |
| 620 | 2492 | 3.70 | 1.22 | 44.37 | 54.80 | 1.64 | 1.00 | 11,114 | 11,114 | 5.90 |
| 620 | | | .48 | 46.07 | 57.48 | 1.17 | 1.00 | 11,114 | 11,114 | 5.57 |
| 640 | 2491 | 5.40 | 5.65 | 44.01 | 56.19 | 3.00 | 1.64 | 11,114 | 11,114 | 5.97 |
| 640 | | | 2.41 | 45.04 | 50.24 | 3.11 | 1.61 | 11,114 | 11,114 | 5.40 |
| 65 | | | .08 | 47.87 | 60.71 | 50.25 | 1.69 | 11,114 | 11,114 | 5.61 |
| 67 | | | 1.51 | 44.58 | 42.09 | 10.80 | 1.14 | 11,114 | 11,114 | 6.13 |
| 70 | 2490 | 3.70 | 1.35 | 44.97 | 53.41 | 10.34 | 1.13 | 11,114 | 11,114 | 5.61 |
| 74 | 2494 | 5.40 | 5.81 | 44.74 | 60.24 | 22.24 | 1.00 | 11,114 | 11,114 | 5.61 |
| 75 | 4151 | 3.00 | 5.51 | 42.85 | 61.34 | 17.30 | 1.84 | 11,114 | 11,114 | 5.61 |
| 76 | 2488 | 5.20 | 6.01 | 42.98 | 58.40 | 2.54 | 1.01 | 11,114 | 11,114 | 4.40 |
| 80a | 4137 | 5.20 | 7.74 | 45.57 | 67.84 | 8.80 | 0.96 | 11,114 | 11,114 | 3.61 |
| 80b | 4152 | 2.70 | 5.71 | 43.04 | 47.40 | 34.45 | 0.44 | 11,114 | 11,114 | 1.50 |
| 80c | 4440 | 4.20 | 6.12 | 44.72 | 54.14 | 31.05 | 0.75 | 11,114 | 11,114 | 1.50 |
| 81 | 4127 | 4.60 | 5.14 | 43.60 | 55.90 | 5.00 | 1.46 | 11,114 | 11,114 | 5.29 |
| Average | | | 4.19 | 44.00 | 52.42 | 9.50 | 1.13 | 11,114 | 11,114 | |

ANTHRACITE AND SEMIBITUMINOUS.

| | | | | | | | | | | |
|----|--|--|------|-------|-------|------|--|--|--------|--|
| 83 | | | 4.75 | 43.48 | 57.46 | 7.41 | | | | |
| 84 | | | 3.90 | 7.72 | 84.71 | 5.41 | | | | |
| 85 | | | 2.03 | 5.81 | 85.48 | 6.46 | | | | |
| 86 | | | 1.04 | 7.09 | 84.70 | 6.46 | | | | |
| 87 | | | 2.15 | 8.43 | 86.04 | 7.68 | | | | |
| 88 | | | 2.68 | 14.08 | 77.88 | 5.40 | | | | |
| 89 | | | 2.45 | 6.40 | 85.44 | 6.00 | | | | |
| 90 | | | 1.75 | 12.28 | 84.00 | 4.24 | | | | |
| 91 | | | 3.12 | 45.61 | 69.03 | 1.94 | | | 11,114 | |
| 92 | | | 5.33 | 47.54 | 70.96 | 6.68 | | | 11,114 | |

DESCRIPTION OF COAL SECTIONS IN BERING RIVER FIELD.¹

The numbers correspond with those in the foregoing table and on the map of the Bering River coal field (in pocket).

¹ Coal sections 1 to 81 were measured by the Geological Survey in 1904-1905, sections 84 to 92, by the Bureau of Mines in 1915.

ANTHRAHITE.

1. Leasing unit No. 60; crest of Carbon Mountain 2½ miles north-northwest of Fourth Berg Lake.

| | | |
|----------------------|-----|-----|
| | Fl. | In. |
| Coal, hard and clean | 3 | 0 |

- 2 (Lab. No. 2470). Leasing unit No. 50; 14 miles up creek from Fourth Berg Lake.

| | | |
|-------------------|-----|-----|
| Roof, dark shale. | Fl. | In. |
| Coal 1 | 0 | 8 |
| Coaly shale | 0 | 1 |
| Coal 1 | 0 | 11 |
| Coaly shale | 0 | 3 |
| Coal 1 | 0 | 8 |

| | | |
|-------------------------------|---|----|
| Floor, shale. | | |
| Thickness of bed | 2 | 10 |
| Thickness of coal sampled | 2 | 3 |
| Strike N. 70° W., dip 65° SW. | | |

- 3 (Lab. No. 2485). Leasing unit No. 50; in gulch at head of Second Berg Lake.

| | | |
|-------------------------------|-----|-----|
| Roof, sandstone. | Fl. | In. |
| Coal, heavy | 0 | 6 |
| Coal, hard and bright | 2 | 2 |
| Floor, sandy shale. | | |
| Thickness of bed | 2 | 8 |
| Thickness of coal sampled | 2 | 2 |
| Strike N. 80° W., dip 32° NE. | | |

4. Leasing unit No. 50; third opening from the west end of hillside trail, east side of Carbon Mountain.²

| | | |
|-------------------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal | 10 | 0 |
| Floor, shale. | | |
| Strike N. 60° E., dip 23° NW. | | |

- 5 (Lab. No. 2480). Leasing unit No. 50; second opening from west end of hillside trail, east side of Carbon Mountain.²

| | | |
|---------------|-----|---|
| Roof, shale. | Fl. | |
| Coal 1 | 15 | 1 |
| Floor, shale. | | |

Strike N. 77° E., dip 22° NW.

It was not possible to obtain a complete measurement of this coal, which is reported as being 23 to 25 feet thick.

- 6 (Lab. No. 2483). Leasing unit No. 50; first opening from west end of hillside trail, east side of Carbon Mountain.²

The coal at this point measured 10 feet 6 inches and the entire thickness was sampled.

- 7 (Lab. No. 2487). Leasing unit No. 50; 200 feet below hillside trail on east side of Carbon Mountain.

| | | |
|-------------------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal 1 | 4 | 8 |
| Floor, shale. | | |
| Strike N. 80° W., dip 30° NE. | | |

This bed is about 200 feet below that measured in sections 4, 5, and 6. Several other beds are exposed lower down the face of the mountain.

- 8 (Lab. No. 2406). Leasing unit No. 50; north end of hillside trail on west side of Carbon Mountain.²

| | | |
|---------------------------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal, bright, clean and often friable | 15 | 0 |
| Floor, shale. | | |
| Strike N. 81° W., dip 25° NE. | | |

- 9 (Lab. No. 2482). Leasing unit No. 40; south end of hillside trail on west side of Carbon Mountain.²

| | | |
|------------------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal 1 | 10 | 0 |
| Floor, shale. | | |
| Strike N. 52° E., dip 6° SE. | | |

SEMIANTHRAHITE.

- 10 (Lab. No. 2481). Leasing unit No. 40; opening on west side near crest of Carbon Mountain.

| | | |
|-------------------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal 1 | 6 | 3 |
| Floor, shale. | | |
| Strike N. 82° E., dip 38° NW. | | |

This coal has the physical characteristics of the anthracite found in the other openings in the vicinity, but its analysis indicates a semianthracite coal.

- 11 (Lab. No. 2479). Leasing unit No. 40; west side near crest of Carbon Mountain, 50 feet below section 10.

| | | |
|---------------------|-----|-----|
| Roof, shale. | Fl. | In. |
| Coal, impure | 3 | |
| Coal, good and hard | 2 | 10 |

¹ Included in sample.

² Measurements 1, 3, and 4 are probably on the same bed, which former claimants claim to have followed along the mountain side for 2 miles, finding thicknesses ranging from 0 to 23 feet.

³ This bed is apparently very pure and is possibly the same bed as that measured in sections 4, 5, and 6.

| | | |
|-------------------------------|-----|-----|
| Floor, shale. | Fl. | In. |
| Thickness of bed | 3 | 1 |
| Thickness of coal sampled | 2 | 10 |
| Strike N. 82° E., dip 38° NW. | | |

This coal has the physical characteristics of the anthracite found in the other openings in the vicinity, but its analysis indicates a semianthracite coal.

12. Leasing unit No. 45; west bank of Canyon Creek near source.

| | | |
|------|-----|-----|
| | Fl. | In. |
| Coal | 5 | 0 |

13. Leasing unit No. 45; west bank of Canyon Creek 500 feet below glacier.

| | | |
|------|-----|-----|
| | Fl. | In. |
| Coal | 3 | 0 |

14 (Lab. No. 4401). Leasing unit No. 49; prospect on tributary to Canyon Creek on east side and next below Hunt's cabin.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Coal ¹ | 6 | 9 |
| Strike N. 55° W., dip 31° NE. | | |

15. Leasing unit No. 49; prospect on tributary to Canyon Creek on east side and next below Hunt's cabin.

| Roof, shale. | Ft. | In. |
|------------------------------|-----|-----|
| Coal..... | 3 | 0 |
| Floor, shale. | | |
| Strike N. 65° E., dip 60° NW | | |

16 (Lab. No. 4433). Leasing unit No. 49; on same creek as Nos. 14 and 15, about 100 feet above stream.

| Roof, firm shale. | Ft. | In. |
|-------------------------------|-----|-----|
| Coal..... | 2 | 7 |
| Floor, shale | | |
| Strike N. 55° E., dip 46° NW. | | |

17. Leasing unit No. 49; tunnel on east bank of Canyon Creek 2½ miles above mouth, near Hunt's cabin.

| Roof, shale. | Ft. | In. |
|-------------------------------|-----|-----|
| Coal..... | 4 | 2 |
| Floor, shale. | | |
| Strike N. 40° E., dip 60° NW. | | |

18. Leasing unit No. 49; east bank of Canyon Creek 2 miles above mouth.

| Roof, sandstone. | Ft. | In. |
|--|-----|-----|
| Coal..... | 2 | 9 |
| Floor, shale. | | |
| Strike N. 70° W., dip 35° NE. | | |
| This bed is variable in thickness and pinches out higher in the bluff. | | |

19 (Lab. No. 4402). Leasing unit No. 48; creek on west slope of Carbon Mountain opposite the mouth of Canyon Creek.

| Roof, shale. | Ft. | In. |
|--|-----|-----|
| Coal..... | 1 | 0 |
| Shale..... | 1 | 0 |
| Coal ¹ (ranges from 3 to 21 inches)..... | 1 | 5 |
| Shale (ranges from 1 to 18 inches)..... | 0 | 1 |
| Coal ¹ (ranges from 14 to 24 inches)..... | 1 | 2 |
| Floor, hard shale. | | |
| Thickness of bed..... | 4 | 8 |
| Thickness of coal sampled..... | 2 | 7 |
| Strike (variable) N. 25° E., dip 63° NW. | | |

20 (Lab. No. 4459). Leasing unit No. 48; creek on west slope of Carbon Mountain opposite the mouth of Canyon Creek.

| Roof, arkose | Ft. | In. |
|---|-----|-----|
| Coal ¹ (ranges from 8 to 22 inches)..... | 1 | 8 |
| Floor, arkose. | | |
| Strike N. 90° E., dip 33° N. | | |

21. Leasing unit No. 16; south end of Carbon Mountain

| | Feet. |
|--|-------|
| Sandstone..... | 30 |
| Coal..... | 1 |
| Sandstone and shale cut by diabase sill..... | 20 |
| Coal..... | 2 |
| Diabase sill..... | 2 6 |
| Coal ¹ | 4-5 |
| Diabase sill..... | 3 |
| Coal..... | 1 |
| Diabase sill..... | 8 |
| Coal..... | 14 21 |
| Shale..... | 120 |
| Strike N. 50° W., dip 20 30° NE | |

22. Leasing unit No. 38; south tunnel on north bank of Clear Creek.

| Roof, shale | Ft. | In. |
|---------------|-----|-----|
| Coal..... | 2 | 10 |
| Floor, shale. | | |

23 (Lab. No. 4431). Leasing unit No. 38; tunnel on north bank of Clear Creek near top of falls.

| Roof, shale | Ft. | In. |
|--------------|-----|-----|
| Coal..... | 18 | 0 |
| Floor, shale | | |

24. Leasing unit No. 38; stripping on northwest bank of Clear Creek above falls.

| | Feet. |
|-----------|-------|
| Coal..... | 47 |

25. Leasing unit No. 38; stripping on northwest bank of Clear Creek above falls, south of No. 24.

| | Feet. |
|-----------|-------|
| Coal..... | 31 |

26 (Lab. No. 4435). Leasing unit No. 30; base of Clear Creek Falls.

| Shale. | Feet. |
|--|-------|
| Diabase sill..... | |
| Coal (ranges from 6 to 12 inches)..... | 4 |
| Coal ¹ | 6 |
| Coal..... | 11 |
| Floor, shale. | |
| Thickness of bed..... | 17 |
| Thickness of coal sampled..... | 6 |
| Strike N. 65° E., dip 45° NW. | |

This bed varies considerably in thickness within short distances. A measurement at the base of the falls showed 8 feet 2 inches coal, while one at the tunnel a few yards away gave a total of about 16 feet.

27 (Lab. No. 4460). Leasing unit No. 33; tributary to Clear Creek, heading southeast of Mount Monument Mountain.

| Roof, firm shale. | Ft. | In. |
|------------------------------|-----|-----|
| Coal..... | 1 | 4 |
| Shale, hard..... | | 7 |
| Shale, soft, with some coal. | 1 | 2 |
| Shale..... | | 3 |
| Coal ¹ | | 3 1 |

¹ Included in sample.

| | | |
|----------------------------------|-----|-----|
| Floor, sandstone; built at floor | | |
| cut off coal above it. | ft. | in. |
| Thickness of bed | 8 | 4 1 |
| Thickness of coal sampled | 3 1 | |
| Strike N. 86° E., dip 30° NW. | | |

28 (Tab. No. 4434). Leasing unit No. 34; tributary to Clear Creek, heading southeast of Monument Mountain.

| | | |
|-------------------|-----|-----|
| Roof, firm shale | ft. | in. |
| Coal ¹ | 1 | 10 |
| None. | | 4 |
| Coal ¹ | | 14 |

HEMISPHERIC COAL.

29 (Tab. No. 4454). Leasing unit No. 34; east bank of Clear Creek 2.0 mile above mouth.

| | |
|-----------------------|-------|
| Roof, foggy sandstone | Feet. |
| Shale, sandy | 3 |
| Coal ¹ | 1 |
| Dibbawath | 1 |

Floor, sandy shale
Strike N. 90° E., dip 67° N.

This is the lowest coal exposed on Clear Creek, although two lower beds are reported on a near by tributary from the north. There is no physical evidence that the intrusion has altered the coal.

30. Leasing unit No. 32; prospect opening on crest of ridge between Trout and Clear Creeks, south of Trail Gap.

| | | |
|-------------------|-----|------|
| | ft. | in. |
| Shale | 1 | 0 |
| Coal | | 1 |
| Shale | | 4 |
| Coal | 10 | 0 |
| Shale | | 1 0 |
| Coal | | 2 4 |
| Shale | | 2 0 |
| Thickness of bed | | 17 0 |
| Thickness of coal | | 12 8 |

Strike N. 70° E., dip 31° NW.

31. On line between leasing units Nos. 30 and 32; crest of ridge between Trout and Clear Creeks, south of Trail Gap, 800 feet south of No. 30.

| | |
|------------------|-------|
| | Feet. |
| Roof, dark shale | 12 |
| Coal | 12 |
| Floor, shale | 8 |

Strike N. 70° E., dip 41° NW.

33 (Tab. No. 5493). Leasing unit No. 24; tunnel on Trout Creek opposite house.

| | |
|-------------------|-------|
| Roof, shale | Feet. |
| Coal ¹ | 8 |
| Floor, shale | |

Strike N. 85° W., dip 28° NE.

34. Leasing unit No. 26; at creek level on Trout Creek, below No. 33.

| | | |
|-------------------|-----|-----|
| | ft. | in. |
| Shale | 1 | 0 |
| Coal ¹ | 6 | 6 |
| Sandstone | 5 | 0 |

Strike N. 70° E., dip 35° NW.

| | | |
|---------------------------|-----|------|
| Roof, firm shale | ft. | in. |
| Coal, heavy | | 7 |
| Coal ¹ | | 3 |
| Coal, shaly | | 3 |
| Coal ¹ | 3 | 3 |
| Shale, heavy | | 5 0 |
| Coal, shaly | | 2 0 |
| Coal | | 1 0 |
| Thickness of bed | | 15 5 |
| Thickness of coal sampled | | 6 3 |

Strike N. 67° E., dip 30° NW.

35. Leasing unit No. 28; east side of Trout Creek below house.

| | | |
|------|-----|-----|
| | ft. | in. |
| Coal | 4 | 6 |

36 (Tab. No. 2484). Leasing unit No. 27; long tunnel one-quarter mile below house on Trout Creek.

| | |
|-------------------|-------|
| Roof, shale | Feet. |
| Coal ¹ | 33 |
| Floor, shale | |

Strike N. 65° E., dip 38° NW.

37. Leasing unit No. 37; tunnel 1,500 feet below house on Trout Creek.

| | | |
|---------------|-----|-----|
| Roof, arkose | ft. | in. |
| Coal | 7 | 7 |
| Floor, arkose | | |

38. Leasing unit No. 27; small tributary of Trout Creek from west, near mouth of Bear Creek.

| | |
|--------------|-------|
| Roof, shale | Feet. |
| Coal | 6 |
| Floor, shale | |

Strike N. 2° W., dip 24° SW.

39. Leasing unit No. 27; small tributary of Trout Creek from west, near mouth of Bear Creek.

| | | |
|------|-----|-----|
| | ft. | in. |
| Coal | 3 | 6 |

Strike N. 25° E., dip 30° NW.

40. Leasing unit No. 37; small tributary of Trout Creek from west, near mouth of Bear Creek.

| | |
|--------------|-------|
| Roof, shale | Feet. |
| Coal | 12 4 |
| Floor, shale | |

Strike N. 15° E., dip 27° NW.

41. Leasing unit No. 24; east side of Kushtaka Ridge one-quarter mile east of U. S. L. M. Kayak No. 4.

| | |
|----------------|-------|
| | Feet. |
| Shale | 30 |
| Coal | 5 |
| Coal and shale | 5 |
| Shale | 10 |
| Coal | 3 |

Floor, shale
Strike N. 38° E., dip 70° NW.

¹ In-bed laminae.

42. Leasing unit No. 24; east side of Kushtaka Ridge.

| Roof, shale: | Feet. | In. |
|-------------------------------|-------|-----|
| Bone... | 0 | 8 |
| Coal... | 3 | 8 |
| Shale... | 0 | 1 |
| Coal... | 3 | 4 |
| Bone... | 0 | 3 |
| Coal... | 1 | 8 |
| Bone... | 0 | 5 |
| Coal... | 1 | 0 |
| Shale... | 0 | 4 |
| Coal... | 0 | 11 |
| Bone... | 0 | 2 |
| Floor, dark shale: | | |
| Thickness of bed... | 12 | 0 |
| Thickness of coal... | 10 | 7 |
| Strike N. 45° E., dip 68° NW. | | |

43 (Lab. No. 4428). Leasing unit No. 23; east side of Kushtaka Ridge, 1½ miles north-northwest of cabin.

| | |
|---------------|-------|
| Roof, shale: | Feet. |
| Coal 1..... | 14 |
| Floor, shale, | |

44 (Lab. No. 4455). Leasing unit No. 23; east side of Kushtaka Ridge, 1 mile north-northwest of cabin.

| | |
|-------------------------------|-------|
| Roof, soft shale: | Feet. |
| Coal 1..... | 3 |
| Floor, soft shale. | |
| Strike N. 77° E., dip 40° NW. | |

45. Leasing unit No. 22; east side of Kushtaka Ridge.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Coal..... | 12-15 | 0 |
| Shale... | 1 | 0 |
| Coal..... | 2 | 0 |
| Shale..... | 2 | 0 |
| Bone..... | 2 | 4 |
| Coal..... | 2 | 0 |
| Bone..... | 0 | 0 |
| Coal..... | 1 | 0 |
| Bone..... | 0 | 1 |
| Coal..... | 2 | 0 |
| Thickness of bed... | 27 | 30 |
| Thickness of coal... | 20 | 23 |
| Strike N. 22° E., dip 58° NW. | | |

46. Leasing unit No. 22; tunnel on trail 2,200 feet north of Kushtaka cabin.

| | |
|-------------------------------|-------|
| Roof, shale: | Feet. |
| Coal (pinching out)... | 10 |
| Strike N. 25° E., dip 42° NW. | |

47. Leasing unit No. 22; near shore of Kushtaka Lake, east of No. 46.

Measurement not available.

48 (Lab. Nos. 2497 and 4463). Leasing unit No. 21; tunnel on east face of Kushtaka Ridge.

| | | |
|--|-------|-----|
| Roof, firm shale: | Feet. | In. |
| Coal, somewhat bony and with pyrite nodules 1..... | 14 | 0 |
| Floor, hard shale. | | |
| Strike N. 65° E., dip 45° NW. | | |

49. On line between leasing units Nos. 20 and 21; Kushtaka Ridge just below U. S. L. M. Kayak No. 4.

| Roof, shale | Feet. | In. |
|-------------------------------|-------|-----|
| Coal | 2 | 2 |
| Coal, shaly | 1 | 0 |
| Shale | 9 | 0 |
| Coal | 1 | 8 |
| Floor, shale. | | |
| Thickness of bed | 16 | 10 |
| Thickness of clean coal | 0 | 10 |
| Strike N. 45° E., dip 61° NW. | | |

50. Leasing unit No. 20, Kushtaka Ridge, 600 feet southeast of U. S. L. M. Kayak No. 4.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Shale, carbonaceous | 2 | 0 |
| Coal | 2 | 3 |
| Shale, carbonaceous | 0 | 5 |
| Strike N. 45° E., dip 65° NW. | | |

51. Leasing unit No. 21; Kushtaka Ridge, 1,300 feet southeast of U. S. L. M. Kayak No. 4.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Roof, shale | 7 | 0 |
| Coal | 3 | 0 |
| Shale | 0 | 6 |
| Coal | 0 | 6 |
| Shale | 0 | 6 |
| Coal | 1 | 0 |
| Floor, shale | 2 | 0 |
| Thickness of bed | 5 | 0 |
| Thickness of coal | 1 | 0 |
| Strike N. 45° E., dip 45° NW. | | |

52. Leasing unit No. 24; crest of Kushtaka Ridge, 1,400 feet southeast of U. S. L. M. Kayak No. 4.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Shale, sandy | 2 | 0 |
| Shale, with coal streaks | 2 | 8 |
| Coal | 8 | 8 |
| Shale, soft | 1 | 0 |
| Strike N. 10° E., dip 10° NW. | | |

53. Leasing unit No. 24; Kushtaka Ridge, 1,700 feet southeast of U. S. L. M. Kayak No. 4.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Roof, shale with coal streaks | 0 | 0 |
| Coal | 1 | 0 |
| Shale | 2 | 0 |
| Coal | 5 | 0 |
| Floor, shale | | |
| Thickness of bed | 8 | 0 |
| Thickness of coal | 0 | 0 |
| Strike N. 40° E., dip 45° NW. | | |

54. Leasing unit No. 20; north bank of Carbon Creek, near headwaters.

| | Feet. | In. |
|-------------|-------|-----|
| Roof, shale | 1 | 0 |
| Coal | 2 | 8 |
| Shale | 0 | 4 |
| Coal | 1 | 11 |

1 Included in sample.

| | | |
|-------------------------------|----|----|
| | 11 | in |
| Floor, shale | 1 | 0 |
| Thickness of bed | 1 | 11 |
| Thickness of coal | 1 | 7 |
| Strike N. 18° E., dip 30° NW. | | |

55 (Lab. Nos. 2480 and 2495). Leasing unit No. 20; northwest bank of Queen Creek.

| | | |
|------------------------------|----|----|
| Roof, shale | 11 | in |
| Coal ¹ | 0 | 0 |
| Shale (pocket?) | 7 | 0 |
| Coal | 2 | 0 |
| Shale | 10 | 0 |
| Coal ² | 31 | 0 |
| Floor, shale | | |
| Thickness of bed | 77 | 0 |
| Thickness of coal | 60 | 0 |
| Strike N. 61° E., dip 1° NW. | | |

56. Leasing unit No. 20; southeast bank of Queen Creek.

| | | |
|-------------------------------|----|----|
| | 11 | in |
| Coal | 11 | 0 |
| Shale | 1 | 0 |
| Coal | 7 | 0 |
| Shale | 0 | 3 |
| Coal | 2 | 0 |
| Shale | 0 | 2 |
| Coal | 10 | 0 |
| Thickness of bed | 37 | 5 |
| Thickness of coal | 33 | 0 |
| Strike N. 66° E., dip 65° NE. | | |

57. Leasing unit No. 20; small creek southwest of Queen Creek.

| | | |
|--------------------------|----|----|
| Roof, shale | 11 | in |
| Coal | 1 | 1 |
| Shale | 3 | 6 |
| Coal | 2 | 2 |
| Shale, with coal streaks | 1 | 6 |
| Coal | 3 | 6 |
| Shale | 0 | 8 |
| Coal | 6 | 8 |
| Shale | 3 | 6 |
| Coal | 11 | 0 |
| Thickness of bed | 33 | 7 |
| Thickness of coal | 24 | 5 |

58 (Lab. No. 2494). Leasing unit No. 20; small creek southwest of Queen Creek.

| | | |
|-------------------|----|----|
| Roof, shale | 11 | in |
| Coal ¹ | 17 | 0 |
| Shale | 11 | 0 |
| Coal | 1 | 0 |
| Shale | 5 | 0 |
| Coal | 3 | 0 |
| Shale | 2 | 6 |
| Coal | 26 | 0 |

| | | |
|----------------------------|----|---|
| Floor, shale, carbonaceous | | |
| Thickness of bed | 98 | 6 |
| Thickness of coal | 50 | 0 |

¹ Included in sample

² Included in sample No. 2484.

59. Leasing unit No. 20; small creek southwest of Queen Creek.

| | |
|-------------------|------|
| | Feet |
| Coal | 14 |
| Shale | 2 |
| Coal | 16 |
| Thickness of bed | 32 |
| Thickness of coal | 30 |

60 (Lab. No. 4463). Leasing unit No. 20; Leeper Creek, one-third of a mile above mouth.

| | |
|-------------------------------|-------|
| | Feet. |
| Coal | 8 |
| Strike N. 40° E., dip 76° NW. | |

61. Leasing unit No. 18; striping on north side of Carbon Creek above the tunnel.

| | |
|-------------------------------|-------|
| Roof, shale | Feet. |
| Coal | 8 |
| Floor, shale | |
| Strike N. 50° E., dip 45° NW. | |

62 (Lab. No. 2492). On line between leasing units Nos. 18 and 19; tunnel on south bank of Carbon Creek.

| | |
|--------------|-------|
| Roof, arkose | Feet. |
| Coal | 8 |
| Floor, shale | |

63. Leasing unit No. 18; north bank of Carbon Creek.

Measurement not available.

64 (Lab. No. 2491). Leasing unit No. 18; tunnel near mouth of Nevada Creek.

| | |
|------------------------------|---------|
| | Ft. in. |
| Roof, dark shale | 2 |
| Coal | 10 |
| Floor, arkose | 0 |
| Strike N. 90° E., dip 78° N. | |

65. Leasing unit No. 16; north end of upper trail on east side of Lake Charlotte.

| | |
|--------------------------------------|---------|
| | Ft. in. |
| Roof, shale | 10 |
| Coal | 0 |
| Shale | 0 |
| Coal with many thin partings of bone | 9 |
| Shale and coal | 6 |

Strike N. 12° E., dip 72° SE.

The coal in this opening is firm and should stand shipment with less crushing than the coal from many other beds in this field, but the amount of ash is excessive.

66. Leasing unit No. 17; prospect opening near Grade Trail Cabin ("Doyle Camp") on east side of Shepherd Creek, 1.4 miles below Lake Charlotte.

| | |
|--------------|---------|
| Roof, shale | Ft. in. |
| Coal | 20 |
| Floor, shale | |

¹ Included in sample No. 2484.

Strike N. 40° E., dip 75° 85° NW.
This bed, which appeared very promising when first opened, has been found to be cut off entirely within a few feet by a fault.

67. Leasing unit No. 7; 1 mile northwest of canon landing on Shepherd Creek.

| | Feet. | In. |
|-------------------------|-------|-----|
| Coal ¹ | 3 | 0 |
| Shale..... | 0 | 2 |
| Coal ¹ | 1 | 4 |
| Thickness of bed..... | 7 | 6 |
| Thickness sampled..... | 7 | 4 |

Strike N. 50° E., dip 66° NW.

68. Leasing unit No. 9; prospect opening on west bank of Tokun Creek, 1.4 miles above Lake Tokun.

| | Feet. |
|-------------------------------|-------|
| Roof, arkose..... | |
| Coal..... | 2 |
| Floor, shale..... | |
| Strike N. 65° E., dip 33° NW. | |

69. Leasing unit No. 0; prospect opening on west bank of Tokun Creek, a short distance above No. 68.

| | Feet. |
|-------------------------------|-------|
| Roof, arkose..... | |
| Coal..... | 3 |
| Floor, shale..... | |
| Strike N. 65° E., dip 33° NW. | |

70. (Lab. No. 2400). Leasing unit No. 8; lower tunnel on Tokun Creek, about 100 yards above No. 60.

| | Feet. | In. |
|-------------------------|-------|-----|
| Roof, arkose..... | | |
| Coal ¹ | 6 | 8 |
| Floor, shale..... | | |

71. Leasing unit No. 8; upper tunnel on Tokun Creek.

| | Feet. |
|-------------------------------|-------|
| Roof, sandstone, shaly..... | |
| Coal..... | 6 |
| Strike N. 78° W., dip 40° NE. | |

72. Leasing unit No. 8; at head of gorge on Trail Creek.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Roof, sandstone..... | 2 | 6 |
| Coal..... | | |
| Floor, sandstone..... | | |
| Strike N. 15° W., dip 55° NE. | | |

73. Leasing unit No. 6; tunnel on tributary to Dick Creek from the east, 1 1/2 miles above the mouth of Dick Creek.

| | Feet. |
|-------------------------------|-------|
| Coal..... | 6 |
| Floor, sandstone..... | |
| Strike N. 15° W., dip 60° NE. | |

74 (Lab. No. 2493). Leasing unit No. 6; tunnel on Powers Creek 1 mile north of Herling Lake.

| | Feet. | In. |
|--------------------------------|-------|-----|
| Coal (top concealed)..... | 2 | 0 |
| Shale..... | 1 | 6 |
| Coal ¹ | 8 | 6 |
| Floor, sandstone..... | | |
| Thickness of bed exposed..... | 12 | 0 |
| Thickness of coal exposed..... | 10 | 6 |
| Strike N. 70° E., dip 35° NW. | | |

¹ Included in sample.

75 (Lab. No. 4154). Leasing unit No. 5, tributary to Yakt Creek one half mile northeast of Christopher's Cabin.

| | Feet. | In. |
|---|-------|-----|
| Roof, shale, etc., with probably a little overlying coal..... | | |
| Coal ¹ | 2 | 2 |
| Shale..... | 0 | 7 |
| Coal..... | 0 | 9 |
| Shale..... | 1 | 10 |
| Coal..... | 0 | 6 |
| Coaly shale..... | 0 | 6 |
| Floor, arkose..... | | |
| Thickness of bed exposed..... | 6 | 8 |
| Thickness of coal exposed..... | 3 | 0 |
| Strike N. 75° E., dip 60° SE. | | |

76 (Lab. No. 2488). Leasing unit No. 6, Christopher prospect by opening in cleft of Falls Creek 1 mile north of Herling Lake.

| | Feet. |
|-------------------------------|-------|
| Roof, arkose..... | |
| Coal ¹ | 3 |
| Coal and shale..... | 3 |
| Coal ¹ | 4 |
| Floor, sandy shale..... | |
| Thickness of bed..... | 10 |
| Thickness sampled..... | 7 |
| Strike N. 20° W., dip 70° NE. | |

77. Leasing unit No. 5; Falls Creek, 1 mile above mouth.

| | Feet. |
|-------------------------------|--------|
| Roof, may ave arkose..... | |
| Coal..... | 6 |
| Shale..... | 1 |
| Coal..... | 2 1/2 |
| Thickness of bed..... | 12 1/2 |
| Thickness of coal..... | 8 1/2 |
| Strike N. 40° E., dip 35° NW. | |

78. Leasing unit No. 3, ridge south of Mount Hamilton.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Coal..... | 1 | 0 |
| Shale..... | 1 | 0 |
| Coal..... | 12 | 6 |
| Shale..... | 1 | 0 |
| Coal..... | 2 | 0 |
| Thickness of bed..... | 17 | 6 |
| Thickness of coal..... | 16 | 6 |
| Strike N. 30° W., dip 60° NE. | | |

79. Leasing unit No. 3, ridge south of Mount Hamilton.

| | Feet. | In. |
|-------------------------------|-------|-----|
| Arkose..... | | |
| Roof, shale..... | 3 | 0 |
| Coal..... | 7 | 0 |
| Shale..... | 0 | 9 |
| Coal..... | 2 | 0 |
| Floor, shale..... | 1 | 0 |
| Thickness of bed..... | 9 | 9 |
| Thickness of coal..... | 9 | 0 |
| Strike N. 80° E., dip 40° NW. | | |

80 (Lab. Nos. 4437, 4432 and 4436). Leasing unit No. 2; gulch two-fifths of a mile southwest of Mount Hamilton.

| | Feet. | In. |
|---|-------|-----|
| Roof, shale..... | 11 | |
| Coal ² | 5 | 0 |
| Shale at top and bottom, concealed between..... | 30 | 0 |

² Included in sample No. 804, Lab. No. 4437.

| | Ft. | in. | |
|--|-----|-----|--|
| Shale, coaly..... | 2 | 0 | 81 (Lab. No. 4427). Leasing unit No. 2; tunnel on shore of Bering Lake, half way between Poul Point and mouth of Dick Creek. |
| Coal, somewhat impure ¹ | 1 | 5 | |
| Shale..... | 0 | 2 | Roof, shale. Ft. in. |
| Coal with shale streaks ¹ | 1 | 4 | Coal..... 0 8 |
| Shale..... | 0 | 4 | Sandstone..... 1 0 |
| Coal with little shale ¹ | 1 | 0 | Shale, coaly..... 0 10 |
| Coal, shaly..... | 0 | 6 | Coal ¹ 4 0 |
| Coal ¹ | 0 | 9 | Shale, soft..... 0 6 |
| Shale..... | 1 | 0 | Possibly some coal below. |
| Coal, impure..... | 0 | 4 | Thickness of bed exposed..... 7 0 |
| Coal ² | 1 | 8 | Thickness of coal exposed..... 4 8 |
| Shale..... | 0 | 2 | Strike N. 76° E., dip 72° NW |
| Coal ² | 4 | 6 | |
| Floor, shaly sandstone | | | 82. Leasing unit No. 1; Poul Point on shore of Bering Lake. |
| Thickness of coal..... | 16 | 6 | Measurement not available. |
| Thickness sampled..... | 33 | 8 | |
| Strike N. 40° E., dip 52° NW. | | | |

ANTHRACITE AND SEMIBITUMINOUS COAL.

83. Leasing unit No. 51; north of Hartline's cabin, in sec. 35, T. 16 S., R. 8 E.
Thickness of coal, 5 9 feet.
84. Leasing unit No. 51; north of place where sample 83 was taken.
Thickness of coal, 10 feet 9½ inches.
85. Leasing unit No. 46; south half of sec. 19, T. 17 S., R. 9 E., near creek emptying into Bering River.
Thickness of coal, 2 feet 9½ inches.
86. Leasing unit No. 46; about one-fourth mile upcreek from sample 85.
Thickness of coal, 4 feet 6 inches.
87. Leasing unit No. 47; near middle of sec. 19, T. 17 S., R. 9 E.
Thickness of coal, 10 feet 7¼ inches.
88. Leasing unit No. 47; near place where sample 87 was taken.
Thickness of coal, 2 feet 6 inches.
89. Leasing unit No. 47; near boundary line of secs. 19 and 24, T. 17 S., R. 8 E.
Thickness of coal, 19 feet 6 inches
90. Leasing unit No. 2; near Bering Lake, in sec. 14, T. 18 S., R. 6 E.
Thickness of coal, 11 feet.
91. Leasing unit No. 34; outcrop on west side of Wardall (Canyon Creek) Ridge, in sec. 10, T. 17 S., R. 8 E.
Thickness of coal, 17 feet 6 inches; dip, 45° NE. The bed is in place, and the strata surrounding it seem as regular as any in the field. The sample was taken from near the grass roots.
92. Leasing unit No. 34; outcrop on west side of Wardall (Canyon Creek) Ridge, in sec. 10, T. 17 S., R. 8 E.
Thickness of coal, 8 feet; dip, 45°. This bed is about 50 feet above the one from which sample 91 was taken. The sample was taken from near the grass roots. The coal would doubtless be better under cover.

¹ Included in sample No. 80b, Lab. No. 4452.² Included in sample No. 80c, Lab. No. 4430.³ Included in sample.

AREA OF LEASING UNITS.

The approximate area, in acres, of the different leasing units in the Bering River coal field is shown by the table below.

Area of leasing units in Bering River coal field.

| No. | Acres | No. | Acres | Acres |
|-----|-------|-----|-------|-------|
| 1. | 120 | 21 | 500 | 210 |
| 2. | 130 | 11 | 100 | 100 |
| 3 | 160 | 21 | 100 | 150 |
| 4 | 110 | 21 | 100 | 110 |
| 5. | 720 | 21 | 100 | 500 |
| 6 | 500 | 20 | 100 | 500 |
| 7. | 600 | 27 | 100 | 810 |
| 8 | 100 | 28 | 100 | 1,000 |
| 9. | 320 | 29 | 100 | 100 |
| 10 | 320 | 30 | 240 | 1,120 |
| 11. | 280 | 31 | 100 | 100 |
| 12. | 610 | 30 | 80 | 1,120 |
| 13. | 100 | 31 | 110 | 1,210 |
| 14 | 350 | 31 | 300 | 800 |
| 15. | 100 | 35 | 500 | 1,200 |
| 16 | 110 | 36 | 100 | 1,100 |
| 17 | 300 | 37 | 100 | 800 |
| 18 | 180 | 38 | 110 | 1,000 |
| 19. | 100 | 39 | 100 | 810 |
| 20. | 500 | 40 | 240 | 900 |

DESCRIPTION OF LEASING UNITS.

Unit No. 1. This unit borders on Bering Lake, a navigable body of water, at Poul Point, in the southernmost part of the Bering Lake district. It is almost entirely underlain by the Kushtuka formation. A measurement of coal was made at point 82, but the results are not available. The route of the suggested railroad along the north shore of Bering Lake traverses the southern and western boundaries of the unit.¹

Unit No. 2. This unit extends from the east shore of Bering Lake to the crest of McDonald Ridge. A part has been shaded on the map (in pocket) to indicate the approximate area of the coal claim patented to T. P. McDonald. The entire unit is underlain by the Kushtuka formation. Coal beds were measured and sampled at points 80, 81, and 90. (See map.) The measurements are given in the list of coal sections on pages 48 to 55, and the analyses in the table on page 48. The route of the suggested railroad along the shore of Bering Lake traverses the western boundary of the unit.¹

Unit No. 3. This unit occupies the summit of McDonald Ridge and extends eastward into the Shepherd Creek drainage basin. It is almost entirely underlain by the Kushtuka formation. Coal beds were measured at points 78 and 79. (See map in pocket.) The measurements are given in the list of coal sections on pages 48 to 55. Coal from this unit will have to be transported either to the shore of Bering Lake, probably through unit No. 2, or to Shepherd Creek Valley. The unit could probably be advantageously combined with unit No. 2.¹

Unit No. 4.—This unit extends from Dick Creek and the shore of Bering Lake to the crest of McDonald Ridge. It is almost entirely

¹ Thorough exploration should precede the expenditure of any large amount of money in development of units 1 to 7. On the basis of the exploratory work so far done, the unit is considered to be a promising one, but some other parts of the Bering River field. Preliminary surveys have already been made for the suggested railroads along the north shore of Bering Lake and up Dick Creek, and up Shepherd Creek.

underlain by the Kushtaka formation. The route of the suggested railroad along the shore of Bering Lake and up Dick Creek traverses the western boundary of the unit.¹

Unit No. 5. This unit extends eastward from Dick Creek, the southeastern corner lying near the summit of McDonald Ridge. The greater part of the unit is underlain by the Kushtaka formation. Coal beds were measured in this unit at points 73, 74, 75, 76, and 77, and samples were taken at points 74, 75, and 76. (See map.) The measurements are given in the list of coal sections on pages 48 to 55, and the analyses of the samples in the table on page 48. The route of the suggested railroad up Dick Creek traverses a part of the western boundary of the unit.²

Unit No. 6. The greater part of this unit lies on the crest of McDonald Ridge. Most of the unit is underlain by the Kushtaka formation. The nearest suggested railroad line runs up Shepherd Creek, and to this any coal which may be produced will doubtless be transported, probably through unit No. 7, with which this unit could doubtless be advantageously combined.¹

Unit No. 7. This unit extends from Shepherd Creek Valley westward to the slope of McDonald Ridge. The Kushtaka formation extends in a strip from northeast to southwest across it; the Tokun formation occupies the northern part, and the Stillwater formation outcrops over a limited area in the southern part. A coal bed was sampled and measured at point 67 (see map), 1 mile northwest of the canoe landing on Shepherd Creek. The measurement is given in the list of coal sections on pages 48 to 55, and the analysis is given in the table on page 48. The route of the suggested railroad up Shepherd Creek passes close to the eastern boundary.¹

Unit No. 8. This unit lies on Tokun Ridge, the southeastern part in the Shepherd Creek drainage basin, the northwestern part in the Tokun Lake drainage basin. It is probable that most of the unit is underlain by the Kushtaka formation. A number of prospects have been opened, some of them containing coal of good quality, but the area as a whole is disturbed. Coal beds were measured at points 70, 71, and 72, and a sample was taken at point 70. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 48. The coal mined will probably be transported to Shepherd Creek Valley for shipment.²

Unit No. 9. This unit extends from the crest of Tokun Ridge westward to and including part of Tokun Creek Valley. It is mainly, if not wholly, underlain by the Kushtaka formation. Coal beds were measured at points 68 and 69. (See map.) The measurements are given in the list of coal sections on pages 48 to 55. A number of prospects have been opened, some of them containing coal of good quality, but as a rule the rocks of the area are disturbed. The coal mined will probably be transported to Shepherd Creek Valley.³

Unit No. 10. This unit is wholly within the Tokun drainage basin and is not accessible to Shepherd Creek Valley except by expensive

¹Thorough exploration would probably require expenditure of any large amount of money in development of units 1 to 7. On the basis of the exploratory work so far done, the conditions are somewhat less promising than in some other parts of the Bering River field. Preliminary surveys have already been made for the suggested railroad along the north shore of Bering Lake and up Dick Creek, and up Shepherd Creek.

²Units 8 and 9 might advantageously be combined with No. 12.

tunneling or difficult surface tramming. Most of the unit is underlain by the Kushtaka formation, but little coal has so far been found.

Unit No. 11.—This unit is wholly within the Tokum drainage basin and is not accessible to Shepherd Creek Valley except by expensive tunneling or by difficult surface tramming. It is underlain in part by the Kushtaka formation and in part by the Tokum formation. Little coal has so far been found.

Unit No. 12. This unit lies mainly within the Shepherd Creek drainage basin. The northwest corner lies on the crest of Tokum Ridge. Most of the unit is probably underlain by the Kushtaka formation, although a strip along the eastern border is underlain by the Stillwater formation. The easternmost boundary of the unit is less than one-half mile from the route of the suggested railroad up Shepherd Creek Valley.

Unit No. 13.—This unit extends from Shepherd Creek Valley westward into Tokum drainage basin. The greater part is probably underlain by the Kushtaka formation. Little prospecting has been done. The route of the suggested railroad up Shepherd Creek passes within a short distance of the eastern boundary.

The unit has been reserved for Government use.¹

Unit No. 14. This unit lies wholly within the drainage of Shepherd Creek and its tributary, Swede Creek. Perhaps three-fourths of the unit is underlain by the Kushtaka formation. Most of the coal beds observed in the unit are disturbed. The route of the suggested railroad up Shepherd Creek touches the southeast corner.

The unit has been reserved for Government use.¹

Unit No. 15.—This unit lies in the Shepherd Creek drainage basin and its eastern boundary is formed in part by the shore of Lake Charlotte. Perhaps two-thirds of the unit is underlain by the Kushtaka formation. The northwest one-third is underlain by the Tokum formation. The route of the suggested railroad up Shepherd Creek traverses the eastern part of the unit.

Unit No. 16.—This unit lies in the Shepherd Creek drainage basin and its northwestern boundary is formed by the shore of Lake Charlotte. The Kushtaka formation extends through the unit in a northeast-southwest strip, bounded in the main by faults. Good coal has been found in the unit and some money has been spent in development work. A coal bed was measured and sampled at point 65. (See map.) The measurement is given in the list of coal sections on pages 48 to 55, and the analysis in the table on page 48. The route of the suggested railroad up Shepherd Creek is near the western boundary. The unit has been reserved for Government use.¹

Unit No. 17.—This unit lies within the Shepherd Creek drainage area. The Kushtaka formation extends through the unit in a northeast-southwest strip, bounded by faults. It is likely that the coal beds will be found to be disturbed. Some good coal has been found, however, and some money has been spent in development work. A coal bed was measured at point 66. (See map.) The measurement is given in the list of coal sections on pages 48 to 55. The unit is traversed by the route of the suggested railroad along Shepherd Creek. It has been reserved for Government use.¹

¹ Units Nos. 13, 14, 16, and 17, reserved for Government use, contain approximately thirty thousand acres each, or 1,600 acres. They represent coal areas that are by no means the best part of the 16,000-acre coal field, but are probably not the most likely disturbed areas. All four units enclose a belt from it along that might be built to Charlotte Harbor up Shepherd Creek.

Kushtaka formation, though the Tokum formation outcrops in the western part. Coal beds were measured at points 15 and 46, and the measurements are given in the list of coal sections on pages 48 to 55. A measurement was also made at point 17, but the results are not available. The route of the suggested railroad along the shore of Kushtaka Lake traverses the eastern boundary of the unit.¹

Unit No. 23. This unit extends from the headwaters of Carbon Creek eastward across Kushtaka Ridge to the valley between Kushtaka Glacier and Kushtaka Lake. The greater part of the unit is underlain by the Kushtaka formation, though the Tokum formation outcrops in the western part. Some good coal has been found, but little work has been done to determine mining conditions. Coal beds were measured and sampled at points 13 and 44. (See map.) The measurements are given in the list of coal sections on pages 48 to 55, and the analyses in the table on page 48. The route of the suggested railroad along the shore of Kushtaka Lake touches the southeast corner of the unit.¹

Unit No. 24. This unit extends from Kushtaka Glacier westward across the headwaters of Carbon Creek to Carbon Ridge. The unit is almost entirely underlain by the Kushtaka formation and coal of good quality outcrops within its boundaries. Coal beds were measured at points 41, 42, 49, 51, 52, and 53. (See map.) The measurements are given in the list of coal sections on pages 48 to 55. The route of the suggested railroad along the north shore of Kushtaka Lake lies less than one-half mile southeast of the eastern border.¹

Unit No. 25. This unit extends from Kushtaka Glacier westward to Charlotte Ridge. The northwestern one third is underlain by the Tokum formation, the remainder by the Kushtaka formation. Coal outcrops in the unit, but little information is available concerning its character. The route of the suggested railroad along the north shore of Kushtaka Lake is about a mile from the southeast corner.¹

Unit No. 26. This unit extends from Trout Creek westward to Kushtaka Glacier. It is mainly underlain by the Kushtaka formation, but the southern part is occupied by the Tokum formation. Whether there is workable coal in the unit is not known. The route of the suggested railroad along the shore of Kushtaka Lake passes just south of the south boundary and a spur has been suggested up Trout Creek, crossing the east end of the unit.²

Unit No. 27. This unit extends from Trout Creek to the Kushtaka Glacier, and is entirely underlain by the Kushtaka formation. Several outcrops of coal occur and about 800 tons of coal was mined in 1913 for the United States Navy. The coal was found to be friable and close timbering was required in mining it. Coal beds were measured in this unit at points 36, 37, 38, 39, and 40 (see map) and a sample was taken at point 36. The measurements are given in the list of coal sections on pages 48 to 55, and the analysis of the sample in the table on page 48. Near the northeast corner of the unit is an exploratory tunnel known as the Trout Creek Tunnel, driven under the direction of the Cunningham claimants. The suggested spur up Trout Creek enters this unit at the southeast corner.²

¹ Units 21, 22, 23, 24, and 25 might advantageously be combined into a single large unit.

² Units 26 to 31, inclusive, might advantageously be combined into one large unit. It would be difficult to carry the suggested railroad spur further north than the southern boundary of unit No. 27.

Unit No. 28. This unit extends from Trout Creek to the Kushtaka Glacier and is entirely underlain by the Kushtaka formation. There are numerous outcrops of good coal within the unit, but the exploratory work done indicates that the beds are irregular. Coal beds were measured at points 33, 34, and 35 (see map) and samples were taken at points 33 and 34. The measurements are given in the list of coal sections on pages 48 to 55, and the analyses of the samples in the table on page 48. The coal will doubtless be transported down Trout Creek Valley, over unit No. 27. The route of the suggested spur up Trout Creek terminates in unit No. 27, about a half mile from the south boundary of unit No. 28.¹

Unit No. 29. This unit extends from the slope of Cunningham Ridge westward to Trout Creek Valley and is almost entirely underlain by the Kushtaka formation. Several outcrops of coal occur near the northern boundary. Some of them contain good coal, but the beds are much disturbed. Very little exploratory work has been done beyond surface prospecting. The route of the suggested railroad up Trout Creek terminates near the southwestern corner of the unit.¹

Unit No. 30. This unit extends from the slope of Cunningham Ridge to Trout Creek Valley, and is almost entirely underlain by the Kushtaka formation. Numerous coal outcrops have been found and coal of good quality has been exposed at some points by surface prospecting. The coal from this unit will doubtless be transported down Trout Creek Valley, probably across unit No. 27.¹

Unit No. 31. This unit extends from the crest of Cunningham Ridge to Kushtaka Glacier and includes the upper part of Trout Creek drainage basin. Part of the unit is underlain by the Kushtaka formation, the remainder by the Tokan formation. There are several outcrops of coal in the unit. The coal will probably be transported down Trout Creek Valley, across units Nos. 28 and 27.¹

Unit No. 32. This unit extends southward along the crest of Cunningham Ridge and eastward into Clear Creek Valley. About two-thirds of the unit is underlain by the Kushtaka formation. The Tokan formation occupies the northern part, and the Stillwater formation is exposed in the extreme southern part. Coal beds of fair thickness, some of them showing good coal, outcrop at many points. The beds in places are much disturbed by folding and faulting. Coal beds were measured at points 30 and 31 in the unit (see map), and the measurements are given in the list of coal sections on pages 48 to 55. The route of the suggested spur up Clear Creek passes near the southeast corner. The unit has been reserved for Government use.

Unit No. 33. This unit extends southeastward from the crest of Cunningham Ridge and occupies a part of Clear Creek Valley. The Kushtaka formation underlies the greater part of the unit, but the Tokan formation outcrops in the northwest corner. Numerous coal beds have been found in the eastern half, particularly along the course of Barrett Creek. Some of these outcrops contain coal of good quality, but many of them are disturbed by folds and faults. The beds were measured and sampled at points 27, 28, and 29. (See map.) The measurements are given in the list of coal sections on

¹ Units 29 to 31, together with unit 32, are not shown on the map, but are combined into one large unit. It would be difficult to carry the suggested railroad spur farther north than the southern boundary of unit No. 27.

pages 48 to 55 and the analyses of the samples in the table on pages 47, 48. The route of the suggested spur up Clear Creek terminates at the southern boundary. The unit has been reserved for Government use.

Unit No. 34.—This unit extends from the summit of Canyon Creek Ridge into Clear Creek Valley. The Stillwater formation occupies the southwestern third of the unit and the remainder is probably underlain by the Kushtaka formation. There are several coal outcrops in the unit and two of them have been measured and sampled at points 91 and 92. (See map.) The measurements are given in the list of coal sections on pages 48 to 55, and the analyses of the samples in the table on page 48. Very little exploratory work has been done. The route of the suggested spur up Clear Creek passes within a quarter of a mile of the northwestern boundary of the unit.

Unit No. 35. This unit extends from the crest of Canyon Creek Ridge to Clear Creek Valley. The larger part is underlain by the Kushtaka formation. Within the unit are numerous outcrops of coal, but little exploratory work has been done to determine their thickness or continuity. The route of the suggested spur up Clear Creek terminates within a quarter of a mile of the western boundary.

Unit No. 36. This unit extends from the crest of Canyon Creek Ridge westward to include a part of Clear Creek Valley. It is entirely underlain by the Kushtaka formation. Little is known concerning the coal beds, but at Clear Creek Falls, near the northern boundary, a small drift has been driven in a bed of good coal showing a thickness of 11 feet at this point. Igneous intrusion near the upper limit of the bed has changed the adjacent coal to natural coke, which ordinarily has no commercial value. A bed was measured and sampled at point 26. (See map.) The measurement is given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 47. The route of the suggested spur up Clear Creek Valley terminates about a half mile from the southwestern corner of the unit.

Unit No. 37. This unit extends from Clear Creek Valley northward to the crest of Cunningham Ridge. About one half is underlain by the Kushtaka formation, the remainder by the Tokun formation. Numerous outcrops of coal have been found, but no exploratory work has been done to determine the thickness or continuity of the beds. The coal will probably be transported down Clear Creek Valley through unit No. 33. The unit has been reserved for Government use.

Unit No. 38. This unit lies at the headwaters of Clear Creek and is almost entirely underlain by the Kushtaka formation. There are coal outcrops in the eastern and northern parts of the unit, and in the southwestern part coal beds are exposed in tunnels driven by the former Cunningham claimants. At the latter point coal about 45 feet in thickness has been exposed, but the disturbed condition of the strata on both sides indicates that trouble will likely be experienced in operating a coal mine. Coal beds were measured at points 22, 23, 24, and 25 (see map), and a sample was taken at point 23. The measurements are given in the list of coal sections on pages 48 to 55, and the analysis of the sample in the table on page 47. The coal from this unit will doubtless be transported down Clear Creek Valley, probably through units Nos. 36 and 33.

Unit No. 39. This unit extends eastward from the crest of Canyon Creek Ridge to Canyon Creek. The southern part is underlain by the Stillwater formation; the rest of it is probably underlain by the Kushtaka formation. Little is known concerning the coal beds in the unit. The route of the suggested spur up Canyon Creek runs within a quarter of a mile of the eastern boundary.

Unit No. 40. This unit extends eastward from the crest of Canyon Creek Ridge to Canyon Creek and is underlain by the Kushtaka formation. No coal beds are known to outcrop in the unit. The route of the suggested spur up Canyon Creek passes through the southeastern corner.

Unit No. 41. This unit extends from the summit of Canyon Creek Ridge eastward to Canyon Creek and is underlain entirely by the Kushtaka formation. Beds of good coal outcrop in the northwest corner, but no exploratory work has been done to determine their continuity. The route of the suggested spur up Canyon Creek runs within a quarter of a mile of the eastern boundary.

Unit No. 42. This unit extends eastward down the slope of Canyon Creek Ridge to Canyon Creek and is entirely underlain by the Kushtaka formation. Beds of good coal outcrop along the western margin, but little work has been done to determine their continuity. The route of the suggested spur up Canyon Creek crosses the southeastern corner of the unit.

Unit No. 43. This unit extends eastward from the crest of Cunningham Ridge to Canyon Creek and is almost entirely underlain by the Kushtaka formation. Beds of good coal outcrop at numerous points but appear to be disturbed by folds and faults. The coal may have to be transported down Canyon Creek, through units Nos. 42 and 51, to the suggested spur up Canyon Creek, which terminates about one-half mile downstream from the southern boundary of the unit.

Unit No. 44. This unit extends eastward from Cunningham Ridge to Canyon Creek. The eastern two thirds is underlain by the Kushtaka formation, the remainder by the Tokun formation. The coal may have to be transported down Canyon Creek through units Nos. 42, 43, and 51, to the suggested Canyon Creek spur.

Unit No. 45. This unit occupies part of the valley of Canyon Creek and is bordered on the north by Martin River Glacier. More than half is underlain by the Kushtaka formation, the remainder by the Tokun formation. Two coal outcrops have been discovered near the northern margin, but the strata enclosing them are badly disturbed. These coal beds were measured at points 12 and 13. (See map.) The measurements are given in the list of coal sections on pages 48 to 55. It will be difficult to transport the coal out of this unit, whether it is taken down Clear Creek or southwestward along Martin River and Kushtaka Glacier.

Unit No. 46. This unit extends from the edge of Bering Glacier westward and is bounded on the northwest by Bering River. It is probably underlain by the Kushtaka formation. Beds of coal of good quality have been found in the northern part. The coal is almost entirely anthracite and ranges in thickness from 2½ to 4 feet. Some of the beds have been traced for a distance of half a mile. Most of the work done on them has been surface prospecting, although at one or two places shallow slopes have been driven. Beds were

measured and sampled at points 21, 83, and 86. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on pages 47, 48. The location of point 21 was inadvertently omitted from the map. It is the SE. $\frac{1}{4}$ of SW. $\frac{1}{4}$ of SE. $\frac{1}{4}$, sec. 21, T. 17 S., R. 8 E., less than a quarter of a mile from Bering River. The route of the suggested spur across Canyon Creek Flats terminates near the northwestern corner of the unit.

Unit No. 47.—This unit extends westward from Bering Glacier across the southern extension of Carbon Mountain to Canyon Creek Flats. It is probably underlain by the Kushtaka formation. Numerous outcrops of coal have been discovered in the western half. Some of the beds exposed are nearly 20 feet thick, but in most of them the coal is crushed and the beds are badly disturbed. Coal beds were measured and sampled at points 87, 88, and 89. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on page 48. The route of the suggested spur across Canyon Creek Flats terminates in the unit near the western boundary.

Unit No. 48.—This unit extends westward from First Berg Lake and Bering Glacier across the southern extension of Carbon Mountain to Canyon Creek Flats. The greater part is probably underlain by the Kushtaka formation. Two well defined coal outcrops have been discovered in the southern part of the unit, and the beds were measured and sampled at points 19 and 20. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on page 48. Other coal outcrops are also reported. The routes of the suggested spur up Canyon Creek and of the suggested spur across Canyon Creek Flats pass within easily accessible distances of the west boundary of the unit.

Unit No. 49.—This unit extends from First Berg Lake westward across Carbon Mountain to Canyon Creek. The greater part is underlain by the Kushtaka formation. Numerous coal outcrops have been observed. Near the crest of Carbon Mountain are several exposures, perhaps all on the same bed, which appear promising. Coal beds were measured at points 9, 10, 11, 14, 15, 16, 17, and 18, and samples were taken at points 9, 10, 11, 14, 16, and 17. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on page 49. A drift about 550 feet in length, driven on a coal bed near the northern boundary not far from Canyon Creek, showed that faulting had disturbed the bed and crushed the coal, rendering it somewhat graphitic. The route of the suggested spur up Canyon Creek crosses the northwestern part of the unit. The approximate location of the Fremont claim of the Alaska Petroleum & Coal Co. is shown in the unit by blue shading. The claim has been approved for patent.¹

Unit No. 50.—This unit extends westward from Bering Glacier and Second Berg Lake across Carbon Mountain to Canyon Creek, First Berg Lake forming a part of the southern boundary. The unit is almost entirely underlain by the Kushtaka formation. On the eastern slope of Carbon Mountain there are four outcrops of coal. Here coal beds were measured at points 4, 5, 6, and 7 (see map).

¹ Units Nos. 49 and 50 might advantageously be combined into a single unit.

and samples were taken at points 5, 6, and 7, and on the western slope a bed was measured and sampled at point 8. The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on page 47. It is possible that the outcrops examined east of Carbon Mountain are all on the same bed, and that the bed exposed at point 8 is also at the same horizon. Very little underground work has been done within the unit. The route of the suggested spur up Canyon Creek crosses the western end. The eastern part of the unit is much more difficult of access.

Unit No. 51. This unit extends from the crest of Carbon Mountain westward to Canyon Creek, and is entirely underlain by the Kushtaka formation. Numerous coal outcrops occur in the unit. Coal beds were measured and sampled at points 83 and 84, near the northern boundary. (See map.) The measurements are given in the list of coal sections on pages 48 to 55 and the analyses of the samples in the table on page 48. This part of the field is within a disturbed zone. Numerous fault planes can be seen in the bluffs of some of the smaller streams, and the coal beds show the effect of movement. The route of the suggested spur up Canyon Creek terminates in the southern part of the unit.

Unit No. 52.—This unit extends from Slope Glacier westward to Canyon Creek and is underlain by the Kushtaka formation. Numerous coal outcrops have been discovered, some of them showing 15 to 20 feet of good coal. Attempts have been made to trace some of the outcrops and it has been thought by some explorers that the beds can be traced for distances greater than 1,000 feet. However, little underground work has been done. The strata outcropping in the east bluffs of Canyon Creek are badly disturbed by faulting and folding. The coal is almost entirely clean, bright anthracite. Most of it is crushed, but some of the smaller beds contain uncrushed coal.

The unit is difficult of access. The course of Canyon Creek in this vicinity is subject to slides; and railroad building within a half mile of the southern boundary of the unit will be attended with difficulty.

Unit No. 53. This unit includes the summit and slopes of Mount Grace. The southwestern corner is on Canyon Creek and the southeastern corner near the margin of Slope Glacier. The greater part, perhaps all, of the unit is underlain by the Kushtaka formation. Numerous coal outcrops have been found, particularly in the southern part. Some of the beds are fairly thick and some of them have been traced for more than 1,000 feet along the strike. The coal appears to be of good quality. Prospecting has been confined to surface work. The problem of transportation will be a serious one. Because of slides the building of a railroad up Canyon Creek will be attended with difficulty. The unit has been reserved for Government use.

Unit No. 54. This unit lies between Slope Glacier and Martin River Glacier and is underlain by the Kushtaka formation. Little is known regarding the occurrence of coal. The unit is difficult of access from any point to which a railroad is likely to be built.

Unit No. 55. This unit is on the southeasterly slope of Carbon Mountain. Second Berg Lake and Third Berg Lake form parts of the southern boundary. The entire unit is underlain by the Kushtaka formation. A few coal beds outcrop, and one was measured and sampled at point 3. (See map.) The measurement is given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 47. This part of the field is disturbed by faulting and folding, as is indicated in the cliffs along the creek flowing into Second and Third Berg Lakes. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 56. This unit occupies the crest of Carbon Mountain, and the northern part lies on Slope Glacier. It is believed that the entire unit is underlain by the Kushtaka formation. Several outcrops of good coal have been discovered along the crest of Carbon Mountain. The structure of this part of the field is complex. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 57. This unit extends eastward from the largest tributary of Third Berg Lake across the ridge between Third and Fourth Berg Lakes. The greater part is probably underlain by the Kushtaka formation. A few coal outcrops are known in the unit. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 58. This unit extends from the largest tributary of Third Berg Lake eastward to the valley of Sheep Creek, and is probably entirely underlain by the Kushtaka formation. A few coal outcrops have been discovered in the unit. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 59. This unit extends eastward from Slope Glacier to Sheep Creek Valley, and is entirely underlain by the Kushtaka formation. A few outcrops of coal are known, and one of the was measured and sampled at point 2. (See map.) The measurement is given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 47. Observations along Sheep Creek indicate the presence of many faults and folds. Some of the thick beds of carbonaceous shale that outcrop within the unit contain small lenses of anthracite coal. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 60. This unit lies northeast of Slope Glacier in the extreme northeastern corner of the Bering River field. It is underlain by the Kushtaka formation. A coal bed was measured at point 4 (see map), and the measurement is given in the list of coal sections on pages 48 to 55. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

¹ The problem of transporting coal from the northern part of Bering River field presents a serious one. There is little likelihood that units 55, 56, 57, 58, 59, or 60 will be given this treatment of transportation. It appears that some means must be devised for transporting the coal to a railroad line along Chukchi Creek or near Bering River. It may be found necessary to drive a tunnel through Carbon Mountain and to construct tramroads connecting the various chukchi with the northern part of this tunnel.

DESCRIPTION OF THE MATANUSKA COAL FIELD.

GEOGRAPHY.

The coal-bearing areas in the Matanuska field are embraced in T. 19 N., Rs. 2, 3, 4, 5, 6, 7, and 8 E.; and T. 20 N., Rs. 4, 5, 6, 7, and 8 E., of the Seward base and meridian.

The Matanuska River, which traverses the coal field, is tributary to Knik Arm of Cook Inlet. It rises on the western edge of the Copper River basin and flows between the Talkeetna Mountains on the north and the Chugach Mountains on the south. The Matanuska is about 80 miles in length, and for about half its distance runs through the coal field. Its fall in that part of its course included in the area here described is about 20 feet to the mile. This rapid fall gives a swift current, because of which and its being overloaded with sediment, and consequently being in most places broken up into many shifting channels over an aggrading flood plain, it is not navigable. The fall is, however, so evenly distributed that there is no available water power. The principal tributaries of the Matanuska in the coal field are Hicks Creek, Chickadee River, Kings River, and Gravel, Monument, Coal, Carbon, Granite, Young, Eska, and Moose Creeks. It is a noteworthy fact that all of the large tributaries of the Matanuska River enter it from the north.

The Matanuska Valley proper has a general width of about 6 miles between approximately parallel and fairly distinct mountain fronts. Within it are rounded hills and gravel-covered flats, the former rising to elevations ranging between about 2,300 and 3,500 feet and the latter to about 1,200 feet. Although some gravel-covered benches are present at the mouths of the tributary valleys at elevations as great as 2,200 feet, the streams occupy narrow valleys, some of which are box canyons, within this broader valley. It is noteworthy that the Matanuska practically throughout its course is nearer the south than the north wall of the valley, in most places hugging the south wall.

ACCESSIBILITY.

At the present time the Matanuska Valley is reached by wagon road and trail from Knik, near the head of navigation on Cook Inlet. Small boats and barges land here at high tide, and there is a good harbor about 1½ miles down the inlet at Anchorage, where ships from Seattle, Portland, and San Francisco land during the summer months.

CLIMATE.

The climate of this district resembles that of the interior of Alaska rather than that of the coast, as the district is a considerable distance from the ocean. The summers are warm, with light rainfall, and the winters cold, with light snows. The severity of the winters is due largely to the high winds through the valley.

TRANSPORTATION FROM THE MATANUSKA COAL FIELD.

The new Government railroad now being built will soon afford communication between the Matanuska coal fields and the ports of Anchorage and Seward. Anchorage (formerly known as Ship Creek) is situated on Knik Arm of Cook Inlet and is 75 miles from Chicka-

Unit No. 55. This unit is on the southeasterly slope of Carbon Mountain. Second Berg Lake and Third Berg Lake form part of the southern boundary. The entire unit is underlain by the Kushtaka formation. A few coal beds outcrop, and one was measured and sampled at point 3. (See map.) The measurement is given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 47. This part of the field is disturbed by faulting and folding, as is indicated in the cliffs along the creek flowing into Second and Third Berg Lakes. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 56. This unit occupies the crest of Carbon Mountain, and the northern part lies on Slope Glacier. It is believed that the entire unit is underlain by the Kushtaka formation. Several outcrops of good coal have been discovered along the crest of Carbon Mountain. The structure of this part of the field is complex. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 57. This unit extends eastward from the largest tributary of Third Berg Lake across the ridge between Third and Fourth Berg Lakes. The greater part is probably underlain by the Kushtaka formation. A few coal outcrops are known in the unit. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 58. This unit extends from the largest tributary of Third Berg Lake eastward to the valley of Sheep Creek, and is probably entirely underlain by the Kushtaka formation. A few coal outcrops have been discovered in the unit. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 59. This unit extends eastward from Slope Glacier to Sheep Creek Valley, and is entirely underlain by the Kushtaka formation. A few outcrops of coal are known, and one of the was measured and sampled at point 2. (See map.) The measurement is given in the list of coal sections on pages 48 to 55 and the analysis of the sample in the table on page 47. Observations along Sheep Creek indicate the presence of many faults and folds. Some of the thick beds of carbonaceous shale that outcrop within the unit contain small lenses of anthracite coal. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

Unit No. 60. This unit lies northeast of Slope Glacier in the extreme northeastern corner of the Bernier River field. It is underlain by the Kushtaka formation. A coal bed was measured at point 1 (see map), and the measurement is given in the list of coal sections on pages 48 to 55. The transportation of coal from this unit to any railroad line likely to be built in the near future presents serious difficulties.¹

¹ The problem of transporting coal from the northern part of Bernier River field (points 1 to 6 on map) is little likelihood that units 55, 56, 57, 58, 59, or 60 will be given this method of communication. It appears that some means must be devised for transporting the coal in a direct line along Carbon Creek or near Bernier River. It may be found necessary to devise a tunnel through the crest of Mountain and to construct tramroads connecting the various claims with the eastern portal of this tunnel.

DESCRIPTION OF THE MATANUSKA COAL FIELD.

GEOGRAPHY.

The coal-bearing areas in the Matanuska field are embraced in T. 19 N., Rs. 2, 3, 4, 5, 6, 7, and 8 E.; and T. 20 N., Rs. 4, 5, 6, 7, and 8 E., of the Seward base and meridian.

The Matanuska River, which traverses the coal field, is tributary to Knik Arm of Cook Inlet. It rises on the western edge of the Copper River basin and flows between the Talkeetna Mountains on the north and the Chugach Mountains on the south. The Matanuska is about 80 miles in length, and for about half its distance runs through the coal fields. Its fall in that part of its course included in the area here described is about 20 feet to the mile. This rapid fall gives a swift current, because of which and its being overloaded with sediment, and consequently being in most places broken up into many shifting channels over an aggrading flood plain, it is not navigable. The fall is, however, so evenly distributed that there is no available water power. The principal tributaries of the Matanuska in the coal field are Hicks Creek, Chickadee River, Kings River, and Gravel Monument, Coal, Carbon, Granite, Young, Eska, and Moose Creeks. It is a noteworthy fact that all of the large tributaries of the Matanuska River enter it from the north.

The Matanuska Valley proper has a general width of about 6 miles between approximately parallel and fairly distinct mountain fronts. Within it are rounded hills and gravel-covered flats, the former rising to elevations ranging between about 2,300 and 3,500 feet and the latter to about 1,300 feet. Although some gravel-covered benches are present at the mouths of the tributary valleys at elevations as great as 2,200 feet, the streams occupy narrow valleys, some of which are box canyons, within this broader valley. It is noteworthy that the Matanuska practically throughout its course is nearer the south than the north wall of the valley, in most places hugging the south wall.

ACCESSIBILITY.

At the present time the Matanuska Valley is reached by wagon road and trail from Knik, near the head of navigation on Cook Inlet. Small boats and barges land here at high tide, and there is a good harbor about 18 miles down the inlet at Anchorage, where ships from Seattle, Portland, and San Francisco land during the summer months.

CLIMATE.

The climate of this district resembles that of the interior of Alaska rather than that of the coast, as the district is at a considerable distance from the ocean. The summers are warm, with light rainfall, and the winters cold, with light snows. The severity of the winters is due largely to the high winds through the valley.

TRANSPORTATION FROM THE MATANUSKA COAL FIELD.

The new Government railroad now being built will soon afford communication between the Matanuska coal fields and the ports of Anchorage and Seward. Anchorage (formerly known as Ship Creek) is situated on Knik Arm of Cook Inlet and is 75 miles from Chickadee

loon, in the Matanuska coal fields. According to the United States Coast and Geodetic Survey, the distance from Anchorage to Seattle is 1,430 miles.

Seward, situated at the head of Resurrection Bay, is 185 miles from Chickaloon and 1,235 miles from Seattle. Coal shipping facilities can be developed at either point without very great expense.

The line of railroad from Chickaloon will follow the northerly side of Matanuska River, southwesterly to Matanuska Junction, a distance of 38 miles. Here connection with the main line leading from Seward to Fairbanks is made and coal can be shipped in either direction. Between Chickaloon and this junction short spurs can be constructed at reasonable expense to reach points in the coal fields, as may seem desirable.

The harbor of Seward is open all the year. The harbor at Anchorage may, during a severe winter, be closed for four or five months, but this is somewhat problematical. It is estimated that coal can be delivered from the coal fields to either of these ports and loaded on ships at from 1 cent to 15 cents per ton mile, exclusive of cost of mining and preparation. This depends on the amount to be transported. It is expected that the railroad to Chickaloon will be completed by the summer of 1917.

COALS OF THE MATANUSKA FIELD.¹

In the present fuel situation in the Territory the Matanuska coal field shares prominence with the Bering River field. It lies northeast of Knik Arm, a northerly embayment of Cook Inlet, and the distance from the nearest coal to Anchorage, the head of steamship navigation on Cook Inlet, is about 50 miles.

The known coal beds of supposed commercial value in the Matanuska coal field occur in folded and faulted rocks of Tertiary (Eocene) age, forming the Chickaloon formation, which is composed of shales and sandstones aggregating 2,000 feet or more in thickness. Some coal is known to occur also in association with a Tertiary conglomerate in the mountainous area north of the Matanuska Valley, but these beds are probably all so thin, lenticular, and low grade that they are of no commercial importance.

The coal-bearing Chickaloon formation has been traced for about 40 miles along the Matanuska Valley, but much of it is buried under a heavy blanket of Quaternary gravels. The known area of the Chickaloon formation and overlying beds is about 90 square miles, and a covered and unsurveyed area of about 52 square miles additional may be underlain by the Chickaloon formation. The total area that may be underlain by commercial coal consequently aggregates about 148 square miles, but as much of this area is covered by gravels, the actual coal bearing area is possibly much smaller.

The available evidence concerning the position of the coal within the Chickaloon formation is by no means conclusive. On Moose and Eeska Creeks the coal apparently lies not far beneath the base of the Eeska conglomerate, but at the base of Crestle Mountain are excellent creek exposures that show no coal within many hundred feet of the base of the conglomerate. It may consequently be assumed that the

¹ Martin, G. C., and Katz, F. J., *Geology and coal fields of the lower Matanuska Valley, Alaska*, U. S. Geol. Survey Bull. 500, 1912, 93 pp.

Martin, G. C., and Meritt, J. H., Jr., *Mineral resources of the upper Matanuska and Chitina Valleys, Alaska*, U. S. Geol. Survey Bull. 562, 1914, pp. 271-299.

coal probably occurs at various horizons within the Chickaloon formation, and that the coal horizons are not persistent.

The commercial coals of the Matanuska field range from lignite or subbituminous to semibituminous. There is also a little anthracite, but it is probably not of commercial importance. The supposedly workable beds range from 5 to 25 feet in thickness.

Throughout the greater part of the Matanuska Valley the structural details are not known, but there is every indication that complex structure is the general condition. It is probable that there are areas in which the structure will permit the mining of the coal, but also that there are larger areas in which the structural conditions will make the mining of the coal difficult and expensive, if not impossible. It will probably be found that where the structure is simple the coal is of low grade. The character of the structure must be regarded as a problem to be solved by underground exploration before the feasibility of mining at a profit the coal of any particular tract can be demonstrated.

The presence of numerous bodies of intrusive rock in the coal field introduces factors that make an undetermined percentage of the coal areas of doubtful value. The size and distribution of these intrusive masses beneath the surface, as well as at the surface in the areas of scanty outcrop, can not be determined without underground exploration. The effect of the smaller intrusive masses on the coal depends on the extent to which these masses have been intruded into or along the surfaces of coal beds. Where the intrusive mass is in contact with the coal, the coal is worthless; but where it is a few feet away, the quality of the coal is probably unimpaired or may even be improved.

The results of tests of Matanuska coal to determine its suitability for use on naval ships is described in a report by the Secretary of the Navy.¹

Analysis of Matanuska coals

[Analysis on basis of coal as received]
OF SUBJECT MININGS

| Sample No. 2 | 1 dozen dry box | Proximate analysis | | | | Ultimate analysis | Loss on air-dry- ing. | Calorific value. | |
|---------------|--------------------|--------------------|--------------------------------|-----------------|-------|-------------------|-----------------------------|------------------|------------------------------|
| | | Total moisture | Volatiles combined hydro | Fixed carbon | Ash | | | Calorific | British thermal units. |
| 1..... | 2211 | 1.0 | 19.62 | 61.19 | 15.61 | 0.37 | 1.6 | ..... | ..... |
| 2..... | 2212 | 2.54 | 21.63 | 60.21 | 15.47 | .50 | .8 | ..... | ..... |
| 3..... | 2219 | 0.14 | 14.96 | 63.81 | 12.17 | .11 | 1.1 | 6,610 | 11,968 |
| 12..... | 2217 | 2.53 | 16.11 | 67.19 | 10.54 | .57 | 1.6 | ..... | ..... |
| 12b..... | 2227 | .90 | 19.60 | 64.00 | 15.60 | .60 | ..... | 8,260 | 11,888 |
| 24..... | 2256 | 17.78 | 36.52 | 51.33 | 0.60 | .12 | ..... | ..... | ..... |
| 30..... | 2224 | 0.60 | 11.10 | 68.21 | 10.97 | .11 | ..... | 6,260 | 11,338 |
| 40..... | 2231 | 10.60 | 30.03 | 49.60 | 5.00 | .25 | 4.6 | ..... | ..... |
| 41..... | 2228 | 4.01 | 11.54 | 69.11 | 11.82 | .38 | ..... | ..... | ..... |
| BUTTE MINING. | | | | | | | | | |
| 25..... | 2215 | 2.61 | 21.85 | 61.02 | 12.14 | 0.50 | 1.8 | ..... | 13,351 |
| 27..... | 2221 | 2.01 | 21.12 | 58.82 | 10.36 | .58 | ..... | 7,274 | 13,093 |

¹ Report on tests of Matanuska coal for naval ships, B. Doc. No. 26, 64th Cong., 1st sess., 1915, 123 pp.

² The number given spread to the north of the Matanuska coal field (in pocket). Of the samples indicated on the map, only analyses of those shown in this table are available.

9. Leasing unit No. 12; Tunnel A, Chickaloon.

| | Ft. | in. |
|-------------------------------|-----|-----|
| Coal in face | 11 | |
| Shale | 5 | 2 |
| Coal | 1 | 4 |
| Bony coal | 1 | 0 |
| Coal | 2 | 1 |
| Coal | 3 | 4 |
| Shale | 11 | |
| Coal | 1 | 10 |
| Shale | 5 | |
| Coal | 2 | 1 |
| Shale | 3 | |
| Coal | 8 | |
| Shale | 3 | |
| Coal | 2 | 9 |
| Shale | 2 | |
| Coal | 1 | 0 |
| Bone | 7 | |
| Shale | 12 | 2 |
| Coal | 5 | |
| Shale | 7 | |
| Coal | 8 | |
| Shale | 5 | |
| Coal | 1 | 8 |
| Shale | 7 | |
| Sandstone | 7 | 11 |
| Shale | 2 | 8 |
| Coal | 8 | |
| Shale | 6 | |
| Coal | 2 | 3 |
| Shale | 5 | |
| Coal | 5 | |
| Shale | 3 | 4 |
| Sandstone | 6 | 1 |
| Shale | 18 | 1 |
| Sandstone | 1 | 0 |
| Shale (at entrance of tunnel) | 41 | 3 |
| Shale (outside of tunnel) | 2 | 6 |
| Coal | 6 | |
| Bony coal | 4 | |
| Shale | 8 | |
| Bone | 6 | |
| Shale | 5 | |
| Talus slope. | | |

10. Leasing unit No. 12; Tunnel B, Chickaloon.

| | Ft. | in. |
|---------------------------|-----|-----|
| Shale | 7 | 8 |
| Coal | 1 | 3 |
| Bone | 4 | |
| Coal | 6 | |
| Sandstone | 5 | 9 |
| Coal | 1 | 0 |
| Bone | 1 | 0 |
| Coal | 0 | 8 |
| Streak of bone | | |
| Coal | 4 | 10 |
| Sandstone | 10 | 8 |
| Shaly coal | 7 | |
| Sandstone | 1 | 0 |
| Bony coal | 2 | 5 |
| Sandstone | 1 | 1 |
| Coal with streaks of bone | 4 | 0 |
| Sandstone | 13 | 1 |
| Coal | 2 | 4 |

| | Ft. | in. |
|-------------------------------|-----|-----|
| Sandstone | 9 | 5 |
| Crusted shaly coal | 3 | 0 |
| Coal | 3 | 6 |
| Bone | 1 | 0 |
| Shale | 6 | 0 |
| Coal | 10 | |
| Bone | 3 | |
| Coal | 1 | 0 |
| Sheared shale | 2 | 0 |
| Coal | 3 | 0 |
| Bone | 7 | |
| Sandstone and shale | 65 | 0 |
| Strike N. 48° W., dip 76° SW. | | |

11. Leasing unit No. 12; Tunnel B, Chickaloon.

| | Ft. | in. |
|-----------------------------------|-----|-----|
| Shale | 7 | 4 |
| Coal | 2 | 4 |
| Shale with coal and bony beds | 5 | 6 |
| Coal | 1 | 6 |
| Shale | 3 | |
| Coal | 4 | 3 |
| Shale | 2 | |
| Coal | 1 | 1 |
| Irregular shale mass | 5 | |
| Coal | 11 | |
| Shale | 8 | |
| Coal | 11 | |
| Shale | 1 | |
| Coal | 1 | 6 |
| Shale with many coaly beds | 11 | |
| Coal | 4 | 2 |
| Shale with coal and bone partings | 7 | |
| Shale | 9 | 0 |
| Coal | 7 | |
| Shale | 2 | 7 |
| Alternating coal and shale | 3 | 2 |
| Coal | 3 | 10 |
| Shale | 12 | 1 |
| Bony nodules | 1 | 0 |
| Coal | 5 | |
| Shale | 8 | 9 |
| Shale with coaly streaks | 1 | 10 |
| Coal | 7 | |
| Shale | 2 | 4 |
| Coal | 1 | 6 |
| Coal | 3 | |
| Shale | 5 | 6 |
| Coal | 9 | |
| Shale | 5 | |
| Coal with bony bands | 2 | 4 |
| Bone and shale with some coal | 1 | 10 |
| Shale | 1 | 10 |
| Coal and bone | 11 | |
| Shale and bone | 9 | |
| Coal | 2 | 10 |
| Shale | 11 | 10 |
| Coaly shale | 9 | |
| Coal with some shaly streaks | 1 | 5 |
| Shale (entrance of tunnel) | 33 | 0 |
| Strike N. 48° W., dip 67° SW. | | |

1 (Present post path on these beds)

2 (Present post path on these beds to tunnel 2. (See note 3, p. 72.)

12. (Lab. Nos. 2215 and 2227). Leasing unit No. 12; Tunnel No. 2, Chitkaloon.

| | Ft. | In. |
|---|-----|-----|
| Hard shale..... | | |
| Bone..... | 5 | |
| Coal ¹ | 8 | |
| Bone ¹ | 5 | |
| Coal ^{1 2} | 2 | 4 |
| Bone ¹ | 1 | 11 |
| Coal ^{1 2} | | 11 |
| Bony coal ¹ | | 6 |
| Shale and bone..... | 2 | 8 |
| Coal ^{1 2} | 1 | 10 |
| Coal, with some bone ¹ | 2 | 5 |
| Coal ^{1 2} | | 2 |
| Bone ¹ | | 10 |
| Hard shale..... | 17 | 6 |
| Coal..... | 6 | 0 |
| Shale (at mouth of tunnel)..... | 20 | 0 |
| Dip almost vertical toward mouth of tunnel. | | |

13. Leasing unit No. 13; Tunnel No. 2, Chitkaloon.

| | Ft. | In. |
|------------------------------|-----|-----|
| Coal..... | 1 | 1 |
| Shale..... | | 1 |
| Coal ³ | 2 | 0 |
| Bony coal..... | 1 | 0 |
| Shale..... | | 7 |
| Coal..... | 1 | 2 |
| Shale..... | 1 | 2 |
| Shale and bony coal..... | 1 | 3 |
| Coal ¹ | 3 | 4 |
| Bony coal and shale..... | 1 | 7 |
| Shale..... | 18 | 0 |
| Bony coal ⁵ | 1 | 0 |
| Coal ⁵ | 2 | 9 |
| Bony coal ⁵ | | 10 |
| Shale..... | 14 | 0 |
| Timbering..... | 11 | 0 |

14. Leasing unit No. 12; Tunnel No. 3, Chitkaloon.

| | Ft. | In. |
|---|-----|-----|
| Shale..... | 10 | 0 |
| Coal..... | 1 | 4 |
| Shale..... | | 6 |
| Bone..... | | 6 |
| Coal..... | 7 | 0 |
| Shale with coal streaks..... | 4 | 6 |
| Strike N. 81° W., dip 72°, 75°, 83° NE. | | |

15. Leasing unit No. 12; Tunnel No. 3, Chitkaloon.

| | Ft. | In. |
|-------------------------|-----|-----|
| Coal..... | 1 | 3 |
| Shale..... | | 3 |
| Coal..... | 3 | 0 |
| Shale..... | 2 | 0 |
| Coal ⁶ | 4 | 0 |

| | Ft. | In. |
|--------------------------------|-----|-----|
| Shale..... | 16 | 0 |
| Coal..... | 1 | 0 |
| Shale..... | 2 | 3 |
| Coal..... | 1 | 10 |
| Shale with coaly streaks..... | 1 | 8 |
| Shale..... | 13 | 0 |
| Coal (cut out goes south)..... | 3 | 4 |
| Shale..... | | 1 |
| Coal..... | | 10 |

16. Leasing unit No. 13; Tunnel C, Chitkaloon.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Shale..... | 25 | 0 |
| Coal..... | | 9 |
| Shale..... | 1 | 0 |
| Coal..... | 2 | 6 |
| Coal, more or less shaly..... | 3 | 2 |
| Shale..... | | 9 |
| Timbering..... | 12 | 0 |

17. Leasing unit No. 13; Tunnel D, Chitkaloon.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Coal..... | 3 | 8 |
| Shale to end of timber..... | 17 | 0 |
| Strike N. 80° W., dip 64° NE. | | |

18. Leasing unit No. 13; Tunnel E, Chitkaloon.

| | Ft. | In. |
|-----------------------------|-----|-----|
| Coal..... | 1 | 5 |
| Bone..... | | 6 |
| Coal..... | 1 | 10 |
| Bone..... | | 11 |
| Coal..... | 2 | 7 |
| Crushed shale and coal..... | 2 | 10 |
| Coal..... | | 10 |
| Sandstone and shale..... | 18 | 0 |

19. Leasing unit No. 13; Tunnel No. 5, Chitkaloon.

| | Ft. | In. |
|------------------------------|-----|-----|
| Shale..... | 10 | 0 |
| Coal..... | 1 | 8 |
| Shale..... | | 6 |
| Bony coal..... | 1 | 8 |
| Shale..... | | 10 |
| Coal..... | 6 | 2 |
| Shale..... | 28 | 0 |
| Strike N. 89° E., dip 51° N. | | |

20. Leasing unit No. 13; Tunnel F, Chitkaloon.

| | Ft. | In. |
|--------------------|-----|-----|
| Coal..... | 1 | 3 |
| Shale..... | | 3 |
| Bone and coal..... | | 3 |

¹ Included in sample (Lab. No. 2215).² Included in sample (Lab. No. 2227).³ Crosscut goes south on this bed.⁴ Crosscut goes north on this bed to tunnel B. (See note 2, p. 71.)⁵ Crosscut goes south to raise.⁶ Measurement made on floor of tunnel, but coal is cut off entirely at the roof by a fault.⁷ The crosscut going south to raise from tunnel 2 should be on this bed.⁸ The 3 foot 4 inch coal in crosscut going south from tunnel 3 should be the second bed beyond the present face of this tunnel.

| | Fl. | In. |
|----------------------------------|-----|-----|
| Coal | 1 | 5 |
| Shale | | 8 |
| Coal | | 4 |
| Bone | | 2 |
| Coal | 2 | 5 |
| Shale | | 3 |
| Coal | 1 | 0 |
| Shale | | 8 |
| Coal | | 10 |
| Shale (to cave in) | 7 | 0 |
| Strike east and west, dip 70° N. | | |

21. Leasing unit No. 8; east bank of Klugh River at bend below coal camp.

| | Fl. | In. |
|--|-----|-----|
| Dark shale with ironstone nodules | | |
| Coal | 1 | |
| Shale | 1 | 4 |
| Coal | | 5½ |
| Parting | | |
| Coal | 10 | |
| Shale | | 6 |
| Coal | 3½ | |
| Shale | | 4 |
| Coal | 1 | |
| Carbonaceous and concretionary shale | 12 | 4 |
| Shale with many thin coal streaks | | 7½ |
| Coal | | 8 |
| Gray shale with ironstone nodules, and sandstone | 153 | 0 |
| Shale | | |
| Coal | | 5 |
| Shale | | 1 |
| Coal | | 6½ |
| Shale | | 3½ |
| Shale with small coal streaks and lenses | | 2 |
| Coal | | 8 |
| Parting | | |
| Coal | 1 | 1½ |
| Shale crushed into small pieces and slickensided | | 0 |
| Coal | | 2½ |
| Shale | 4 | 2 |
| Bright coal | | 8 |
| Coked coal and baked shale | 8 | 0 |
| Dabase sill | | |
| Strike N. 15° E., dip 31° SE. | | |

22. Leasing unit No. 8; tunnel on east bank of Klugh River 100 yards above upper bridge.

| | Fl. | In. |
|--------------------|-----|-----|
| Dense, impure coke | 5 | 0 |
| Bony shale | 1 | 0 |
| Coal | 1 | 0 |
| Shale | | 1 |
| Coal | | 8 |
| Bone | | 1 |
| Coal | 1 | 2 |
| Bony coal | | 0 |
| Coal | 2 | 0 |
| Hard shale. | | |

23. Leasing unit No. 8; open cut 10 feet south of preceding section.

| | Fl. | In. |
|-------------------|-----|-----|
| Coal (no cover) | 3 | 0 |
| Shale | | 2 |
| Coal | 1 | 2 |
| Soft impure coal | | 2 |
| Coal | 1 | 8 |
| Shale | | 3 |
| Coal | | 3 |
| Shale and coal | | 7 |
| Coal | 2 | 8 |
| Hard shale floor. | | |

24. Leasing unit No. 8; Klugh River at upper bridge, west side.

| | Fl. | In. |
|----------------------------------|-----|-----|
| Bone and coal | | 7 |
| Clean coal | 1 | 7 |
| Shale | 4 | 6 |
| Concealed short distance. | | |
| Crushed coal with lenses of bone | 5 | 7 |
| Shale | 1 | 7 |
| Sandy shale | 4 | 0 |
| Coal | 2 | 10 |
| Bone | | 4 |
| Coal | 2 | 10 |
| Coal and bone | | 8 |
| Coal | | 11 |
| Bone | | ½ |
| Coal | 2 | 5 |
| Strike N. 15° W., dip 42° NE. | | |

25 (Lab. No. 2218). Leasing unit No. 8; opening on west bank of Klugh River at upper bridge.

| [On same bed as preceding section.] | | |
|-------------------------------------|-----|-----|
| | Fl. | In. |
| Coal | 2 | 5 |
| Sandstone | | 2 |
| Coal | 1 | 4 |
| Shale | | 1 |
| Coal | 1 | 5 |
| Sandstone | | 1 |
| Bony coal | 1 | 0 |
| Sandstone | | 1 |
| Coal | 3 | 4 |
| Strike N. 15° W., dip 42° NE. | | |

26. Gulch on northwest side of mountain 4 miles north of the mouth of Young Creek ("Red Mountain").

| | Fl. | In. |
|---|-----|-----|
| Shale | | |
| Coal (details obscure, total thickness estimated) | 7± | 0 |
| Coal | | 5 |
| Shale | | 1½ |
| Coal | 1 | 2 |
| Shale | | 1 |
| Coal | | 6 |
| Shale | | 1½ |
| Coal | | 7 |
| Shale | | ¾ |
| Coal | | 4 |
| Shale | | ½ |
| Coal | | 2 |
| Shale | | ¾ |
| Coal | 2 | 0 |

± Included in sample.

Strike, on sandstone below, N. 67° E., dip 54° SE.

About 30 feet stratigraphically above section 26 is another coal bed at least 5 and possibly 10 feet thick, and again 30 feet higher and about 80 feet higher are coal beds largely obscured by talus.

27 (Tab. No. 2223). West bank of Young Creek 3½ miles above mouth.

| | Ft. | In. |
|--------|-----|-----|
| Shale. | 1 | 0 |
| Coal 1 | 15 | 0 |
| Shale. | 6 | |
| Coal | | 6 |

Shale with sandstone bands

Strike N. 15° E (magnetic), dip 20° NW.

28 (Tab. No. 2226). Leasing unit No. 7; west bank of Esko Creek, at elevation 929 feet.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Shale and sandstone. | 1 | 3 |
| Coal 1 | 1 | 1 |
| Shale | 1 | 4 |
| Coal 1 | 1 | 1 |
| Shale | 1 | 3 |
| Coal, bony. | 1 | 3 |
| Shale | 1 | 1 |
| Coal, bony. | 1 | 1 |
| Shale | 1 | 1 |
| Coal with some shale and bone | 2 | 6 |
| Shale | 6 | |
| Coaly shale | 2 | 0 |

Strike N. 57° E., dip 14° NW.

A more complete section in the same bed measures as follows:

29. Leasing unit No. 7; west bank of Esko Creek, at elevation 925 feet.

| | Ft. | In. |
|---|------|-----|
| Sandstone | 15 | 0 |
| Shale | 2 | 0 |
| Coal | 7 | |
| Parting | | |
| Coal | 5 | |
| Parting | | |
| Coal | 5 | |
| Parting | | |
| Coal | 1 | 0 |
| Coal with shaly streaks | 7 | |
| Coal | 10½ | |
| Shale | 1-2½ | |
| Coal (a hard stony nodule was seen in this bed) | 1 | 1 |
| Coaly shale | 1 | 5 |
| Coal | 1 | |
| Shale | 1 | |
| Coal | 3½ | |
| Coaly shale | 3 | |
| Shale | 1 | 0 |
| Coal (a hard stony nodule was seen in this bed) | 7 | |
| Parting | | |
| Coal | 8 | |
| Shale | ½-1 | |
| Coal with several thin shaly beds | 10 | |

Shale (Continued).

| | Ft. | In. |
|--|-----|-----|
| Shale | 8 | |
| Coaly shale | 8 | |
| Coal with many thin shale bands | 1 | 7 |
| Coal (with silicified logs, especially at the top) | 1 | 2-4 |
| Shale | 24½ | 0 |
| Major cleat S. 67° E., dip 83° SW, not well developed. | | |
| Strike N. 57° E., dip 17° NW. | | |

30 (Tab. No. 2224). Leasing unit No. 7; west bank of Esko Creek, about 300 feet upstream from preceding section.

| | Ft. | In. |
|-------------------|-----|-----|
| Shale roof | 3 | 3 |
| Coal 1 | 3 | 3 |
| Shale | 11 | |
| Coal | 5 | |
| Shale | 6 | |
| Coal | 6 | |
| Shale | 4 | |
| Coal | 1 | |
| Shale | 9 | |
| Soft black shale. | | |
| Dip northwest. | | |

31. Leasing unit No. 7; west bank of Esko Creek, 3,000 feet below forks.

| | Ft. | In. |
|----------------------------|-----|-----|
| Shale | 3 | 9 |
| Shale with thin coal beds. | 1 | 0 |
| Coal | 2 | |
| Coaly shale | 0 | |
| Coal | 1 | |
| Rusty shale | 6½ | |
| Coal | 1½ | |
| Parting | | |
| Coal | 4 | |
| Parting | | |
| Coal | 1 | 0 |
| Shale parting | 1½ | 2 |
| Coal | 4 | 6 |
| Shale | 2½ | |
| Coal | 5 | |
| Sandstone | 1 | 2 |
| Bony shale | 2½ | |
| Coal | 3½ | |

Shale and arkose.

Strike west, dip 36° N.

About 100 feet above is the following section:

32. Leasing unit No. 7; west bank of Esko Creek, 3,000 feet below forks.

| | Ft. | In. |
|---|-------|-----|
| Shale, concealed. | 5 | |
| Coal | 1½ | |
| Shale | | |
| Coal (clay-houstone nodules in a 2½ to 5 inch layer near top) | 2 | 2 |
| Shale | 1½ | |
| Coal | 1 | |
| Shale | 2½-3½ | |

1 Included in sample.

| Concealed—Continued. | Ft. | In. |
|--------------------------|-----|-----|
| Shale with veins of coal | 1 | 5 |
| Coal | | 3 |
| Shale with veins of coal | | 7 |
| Coal | | 6½ |
| Shale parting | | ½ |
| Coal | | 8½ |
| Shale | | ½-1 |
| Coal | | 2½ |
| Coaly shale | | 11 |

Shale.
Major cleat E, 30° E., dip 90°. Minor cleat N 53° E., dip 50° SE.

33. Loading unit No. 7; east bank of Eská Creek, at elevation 950 feet.

| Shale. | Ft. | In. |
|---|-----|-----|
| Coaly shale | 1 | |
| Sandstone | 1½ | |
| Coaly shale | 1½ | |
| Coal | 1½ | |
| Shale | 2 | |
| Coal | 2 | 8 |
| Parting | | |
| Coal with shaly bedding | 1 | 0 |
| Shale and arkose | 22 | 0 |
| Arkose | 7 | 0 |
| Concretionary shale | 4 | 10 |
| Coal and shale in minute beds | 6 | |
| Shale | 1 | |
| Coal (contains silicified log near top) | 3 | 4 |
| Parting | | |
| Coal | 3 | |
| Parting | | |
| Coal, with shaly bedding, consisting of a unit of heavy concealed | 2 | 0 |
| Strike N, 50° E., dip 18° SE. | | |

34. Loading unit No. 7; base of cliff on west bank of Eská Creek, at elevation 1,000 feet.

| Shale, concretionary. | Ft. | In. |
|--------------------------------|-----|-----|
| Thick shale with coaly streaks | 1 | 0 |
| Coal | 1 | |
| Shale | 1 | |
| Coal | 1 | 4 |
| Shale | 1 | |
| Coal | 1 | 0 |
| Coal with thin shaly bands | 1 | 5 |
| Shale | 8 | |
| Coal | 7 | |
| Shale | 1 | 0 |

Strike N, 62° E., dip 35° SE. Major cleat E, 48° E., dip 84° NE.

35. Loading unit No. 7; west bank of Eská Creek at elevation 1,000 feet.

| | Ft. | In. |
|------------------------|-----|-----|
| Sandstone (cliff) | 7½ | 10 |
| Soft sandstone | 9 | 0 |
| Shale with little coal | 2 | 0 |

| Concealed, mostly shale | Ft. | In. |
|-------------------------|-----|-----|
| Coal | 80 | 0 |
| Shale | 4 | 2 |
| Shale | 1 | 5 |
| Coal | | 7 |
| Shale | | 14 |
| Coal | | 1 |

Shale, some coal, and ironstone concretions 2 | 0 || Coal with several shale beds | 3 | 9 |
| Shale with ironstone concretions | 9 | 6 |

Coal (with shaly bedding in part and many thin shale partings) 13 | 0 |

| | | |
|-----------|---|---|
| Shale | 3 | 6 |
| Ironstone | | 6 |
| Shale | 3 | 0 |
| Ironstone | 2 | 0 |
| Shale | 5 | 0 |

Coal 9 | || Shale with seams of coal | 1 | 1 |
| Coal | 2 | 0 |
| Shale | | 2½ |

Coal 4 | || Shale | 2 | |
| Coal | 2 | 8 |
| Shale | | 7 |

Coal 1 | 0 || Shale with veins of coal | 2 | 1 |
| Coal | 1 | 1 |
| Shale | | 2 |

Coal containing clay-ironstone nodules 5 | 0 || Shale | | 1½ |
| Coal | | 2½ |
| Shale | | 1½ |

Coal 3 | || Shale | 2 | |
| Coal | 1 | |
| Shale | 1 | 10 |

Shale with bands of coal 6 | || Shale | | 6 |
| Coal | | 2 |

Shale with ironstone bands 14 | 6 || Ironstone | 1 | 3 |
| Shale | 4 | 7 |
| Coal | 1 | 3 |

Shale 5 | 9 || Coal | | 8 |
| Shale | 6 | 0 |
| Ironstone | 1 | 3 |

Gray shale 15 | 0 || Ironstone | 2 | 0 |
| Shale | 28 | 0 |

36. Loading unit No. 7; west bank of Eská Creek about 1,250 feet below forks.

| Sandstone. | Ft. | In. |
|-------------------------------|-----|-----|
| Shale | 7 | 3 |
| Coal and shale | | 6 |
| Coal | 3 | 0 |
| Shale with thin coaly streaks | 1 | 0 |

¹ Major cleat E, 43° E., dip 88° NE.; minor cleat not well developed.

² Major cleat N, 42° E., dip 76° SW.

| Shale—Continued. | ft. | in. | Shale—Continued | ft. | in. |
|--|-----|-----|--|-----|-----|
| Coal | 8 | | Shale | 3 | |
| Shale with occasional streaks of coal | 2 | 8 | Coal with shaly bands | 7 | |
| Coal with many shale bands | 1 | 0 | Shale | 4 | |
| Shale | 2 | 9 | Coal with shaly bands | 13 | 0 |
| Coal with many shale bands | 2 | 5 | Ironstone nodules | 6 | 13 |
| Shale with occasional coal lenses | 4 | 0 | Shale | 2 | 0 |
| Ironstone nodules | 2 | 5 | Coal with shaly bands | 1 | 2 |
| Shale | 2 | 7 | Bright coal | 9 | |
| Bright coal (a nodule seen near top) | 3 | 7 | Parting with lenses of sandstone and shale | 0 | 1 |
| Coal with many thin shaly bands | 1 | 5 | Bright coal | 10 | |
| Shale | 8 | | Shale with some coal | 1 | 2 |
| Coal, somewhat shaly | 1 | 1 | Sandstone | 3 | 9 |
| Coal and shale | 1 | 3 | Strike N. 70° E., dip 15° NW | | |
| Coal | 1 | 3 | | | |
| Shale | 1 | 1 | | | |
| Coal | 1 | 1 | | | |
| Parting | | | | | |
| Coal | 11 | | | | |
| Shale | 2 | | | | |
| Coal | 6 | | | | |
| Shale and coal | 2 | | | | |
| Coal | 4 | | | | |
| Shale and coal | 1 | 1 | | | |
| Coal, bright | 1 | 1 | | | |
| Coal with many thin shale bands | 1 | 2 | | | |
| Gray shale | 2 | 1 | | | |
| Shale with sandstone lenses and ironstone nodules | 3 | 0 | | | |
| (Continued about 60 feet downstream on account of fault (?). Where recommenced there is only 34 feet to base of sandstone heading this section.) | | | | | |
| Shale with a few coaly streaks | 2 | 0 | | | |
| Ironstone nodules | 3 | | | | |
| Shale with coaly lenses | 1 | 2 | | | |
| Bright coal | 1 | | | | |
| Shale | 4 | | | | |
| Bright coal | 1 | 0 | | | |
| Parting | | | | | |
| Coal | 9 | | | | |
| Parting | | | | | |
| Coal | 5 | | | | |
| Shale | 1 | 2 | | | |
| Bright coal | 1 | 2 | | | |
| Shale | 1 | 2 | | | |
| Coal with shaly bands | 8 | | | | |
| Shale | 10 | | | | |
| Coal lens | 0 | 2 | | | |
| Shale | 1 | 4 | | | |
| Coal | 2 | 5 | | | |
| Shale | 2 | 8 | | | |
| Ironstone nodules | 4 | 0 | | | |
| Shale | 5 | 9 | | | |
| Ironstone nodules | 0 | 10 | | | |
| Shale | 3 | 0 | | | |
| Coal | 2 | 0 | | | |
| Shale | 1 | 5 | | | |
| Coal with shaly bands | 1 | 0 | | | |

37. Lensing unit No. 7; west bank of Echa Creek about 1,100 feet below fork.

| | ft. | in. |
|-------------------------------------|-----|-----|
| Sandstone | 15 | 0 |
| Shale | 1 | 0 |
| Coal | 1 | 1 |
| Shale | 2 | |
| Coal | 1 | 4 |
| Parting | | |
| Coal | 8 | 1 |
| Shale | 1 | 1 |
| Dirty coal | 9 | 1 |
| Coaly shale | 10 | |
| Coal | 8 | |
| Coaly shale | 4 | 9 |
| Shale | 4 | 2 |
| Coal | 1 | 1 |
| Coaly shale | 10 | |
| Shale | 8 | 0 |
| Coal | 2 | 2 |
| Shale | 1 | |
| Coal | 1 | 2 |
| Parting | | |
| Coal | 1 | 0 |
| Coaly shale | 2 | 10 |
| Coal | 4 | |
| Shale | 1 | |
| Coal | 9 | |
| Shale | 1 | 1 |
| Coal | 9 | |
| Shale | 1 | 1 |
| Coal | 2 | 1 |
| Shale | 1 | 7 |
| Shale with thin bands of coal | 3 | 3 |
| Shale with thin bands of coal | 3 | 9 |
| Coal | 4 | 2 |
| Coal | 1 | 5 |
| Shale | 6 | |
| Coal | 5 | |
| Shale | 2 | 0 |
| Coal | 2 | 0 |
| Shale with ironstone nodules | 9 | |
| Coal | 3 | |
| Shale | 1 | 1 |
| Coal | 1 | 4 |

| | | | |
|--|--------|---|---------|
| Shale Contorted | Ft. in | 38. Esku Creek 1,550 feet above third forks, at elevation 1,650 feet. | |
| Shale with coaly bands | 6 | Shale. | Ft. in. |
| Coal | 1 3 | Coaly shale | 6 |
| Shale | 14 | Coal | 5 |
| Coal | 5 | Coaly shale | 2 0 |
| Shale with few thin bands of coal | 2 3 | Coal with many thin shale bands | 6 0 |
| Coal | 4 | Shale. | |
| Shale with many bands of coal | 8 | Strike N. 66° E., dip 65° SE. | |
| Shale with ironstone | 13 4 | 39. Leasing unit No. 4; east bank of Moose Creek 13,000 feet above U. S. L. M. No. 6. | |
| Shale with a few bands of coal | 7 | Carbonaceous shale with ironstone nodules. | |
| Coal (not well exposed where measured) | 2 0 | Carbonaceous shale with seams of bony coal | Ft. in. |
| Shale | 3 0 | Coal | 1 0 |
| Coal | 24 | Bony and shale | 7 |
| Shale | 34 | Coal | 1 |
| Coal | 10 | Coal | 10 |
| Shale | 24 | Bony | 2 |
| Coal | 0 | Coal | 0 |
| Shale with thin bands of coal | 24 | Shale with coaly streaks | 7 0 |
| Shale with some ironstone | 27 0 | Coal | 1 0 |
| Sandstone, upper foot shaly | 4 0 | Shale | 14 |
| Shale with some ironstone nodules and petrified sticks | 10 0 | Coal | 3 |
| Ironstone | 3 | Shale | 4 |
| Shale with bands of coal | 1 0 | Coal | 1 5 |
| Coal | 74 | Bony | 1 |
| Parting | | Coal | 10 |
| Coal | 1 1 | Nodular shale. | |
| Shale | 3 0 | Strike N. 65° E., dip 83° SE. | |
| Ironstone | 4 | 40 (Tab. No. 2221). Leasing unit No. 2; east bank of Moose Creek about 100 yards below upper cabin. | |
| Shale | 1 3 | Coal with hard ferruginous im- | Ft. in. |
| Ironstone | 3 | fusions | 3 0 |
| Shale | 1 0 | Shale | 2 0 |
| Shale with bands of coal | 10 | Coal (bright) ¹ | 4 6 |
| Shale | 7 | Shale | 2 |
| Coal | 6 | Coal (bright and hard) ¹ | 7 0 |
| Shale | 1 10 | Soft shaly coal | 1 0 |
| Coal | 5 | Soft shale with abundant ironstone concretions. | |
| Shale | 10 | Strike N. 77° E., dip 43° NW. | |
| Coal | 4-12 | 41. Leasing unit No. 2; east bank of Moose Creek 700 feet above U. S. L. M. No. 6. | |
| Shale with bands of coal | 1 4 | | Ft. in. |
| Shale with sandstone and ironstone nodules (cliff) | 37 0 | Shale | 58 0 |
| Coal (petrified log seen in thin bed) | 10 | Arkoso | 8 0 |
| Coaly shale | 2 | Shale | 10 0 |
| Ironstone | 4-8 | Bony | 1 |
| Shale | 8 0 | Parting | |
| Ironstone | 8 | Coal ² | 84 |
| Shale | 3 5 | Parting (slight) | |
| Ironstone nodules | 7 | Coal | 7 |
| Shale with ironstone nodules | 3 4 | Coal, somewhat bony | 4 |
| Shale with little stringers of coal | 5 | Coal with shaly bands | 14 |
| Shale | 1 10 | Black shale with few coaly streaks | 5 |
| Shale with coaly streaks | 10 | Coal with shale streaks | 6 |
| Ironstone nodules | 5 | Black shale | 2 0 |
| Shale with ironstone nodules | 3 0 | Ironstone concretions | 2 0 |
| Clay ironstone | 2 10 | | |
| Gray to blue shale | 4 0 | | |
| Sandy shale, somewhat massive | 3 0 | | |

¹ Included in sample. ² Major cleat N. 65° E., dip 48° SE.; minor cleat N. 25° W., dip 74° NE.

| | ft. | in. |
|--|-----|-----|
| Black and gray shale | 10 | 0 |
| Coal, dirty | 3 | 0 |
| Shale | 3 | 0 |
| Coal with lenses of ferruginous nodules 2 inches thick | 1 | 6 |
| Shale with some coal | 1 | 6 |
| Shale with ironstone nodules | 3 | 0 |
| Impure coal | 10 | 0 |
| Shale with ironstone nodules | 2 | 0 |
| Coal with much shale | 1 | 0 |
| Shale with ironstone nodules | 1 | 0 |
| Impure coal | 1 | 0 |
| Shale with nodules and a few thin bands of coal | 10 | 0 |
| Coal with lenses of ferruginous nodules 2 inches thick | 0 | 0 |
| Strike N. 78° E., dip 71° NW. | 3 | |

42. Leasing unit No. 2; one-eighth of a mile below upper falls, Moose Creek.

| | ft. | in. |
|------------------------------------|-----|-----|
| Shale and sandstone roof | 7 | 0 |
| Dirty coal | 3 | 0 |
| Shale | 1 | 0 |
| Sandstone nodules | 1 | 0 |
| Bone and coal | 1 | 3 |
| Bone | 1 | 0 |
| Coal | 3 | 0 |
| Bone and shale | 3 | 0 |
| Coal | 1 | 3 |
| Bone | 1 | 0 |
| Coal | 6 | 0 |
| Shale | 1 | 0 |
| Shale and sandstone | 3 | 6 |
| Coal | 8 | 0 |
| Shale | 1 | 0 |
| Shale and sandstone | 3 | 4 |
| Coal | 8 | 0 |
| Shale and bone | 1 | 6 |
| Shale | 26 | 1 |
| Clear coal | 3 | 0 |
| Slide | | |
| Coal | 8 | 0 |

43. (Lab. No. 2225). Leasing unit No. 3; near upper end of Moose Creek gorge at elevation 760 feet.

| | ft. | in. |
|------------------------------------|-----|-----|
| Sandstone | 2 | 0 |
| Coal | 1 | 0 |
| Sandstone | 2 | 4 |
| Bright coal ¹ | 6 | 0 |
| Shale | 2 | 0 |
| Bright coal ¹ | 1 | 2 |
| Dull coal ¹ | 1 | 0 |
| Shale | 1 | 6 |
| Dull coal | 1 | 6 |
| Shale | | |
| Strike N. 7° E., dip 21° SE. | | |

44. Line between leasing units 1 and 3; east bank of Moose Creek 1,550 feet below U. S. L. M. No. 5.

| | ft. | in. |
|-----------------|-----|-----|
| Shale | 2 | 0 |
| Coal | 2 | 0 |
| Shale | 2 | 0 |

| | ft. | in. |
|--|-----|-----|
| Shale | 1 | 4 |
| Coal | 2 | 0 |
| Ferruginous nodules | 5 | 0 |
| Coal | 9 | 0 |
| Coal and shale | 6 | 0 |
| Coal | 1 | 0 |
| Coal with several thin beds of shale | 3 | 0 |

Gray shale
Sandstone

Strike N. 30° E., dip 1° SE.

45. Creek flowing northwest into Boulder Creek from near the west end of Anthracite Ridge, altitude 3,700 feet.

Coal bed (one bed concealed) near outcrop of dark shale
Strike N. 68° W., dip 61° SW

46. South face of Anthracite Ridge, 2 miles east of its west end, altitude 3,000 feet.

Coal bed (one bed concealed) near outcrop of dark shale
No exposure obtainable.

47. Creek bed 1 1/2 miles N. 51° W. from 3,750 feet peak at head of Paranton Creek, altitude 3,350 to 3,500 feet.

| | ft. | in. |
|--------------------------|-----|-----|
| Crumpled shale | 30 | 0 |
| Coal | 1 | 1 |
| Shale | 6 | 0 |
| Sandstone | 21 | 0 |
| Shale | 25 | 0 |
| Coal | 1 | 0 |
| Shale | 25 | 0 |
| Sandstone | 18 | 0 |
| Shale | 18 | 0 |
| Sandstone | 36 | 0 |
| Shale | 3 | 0 |
| Coal | 8 | 0 |
| Shale | 12 | 0 |
| Sandstone | 21 | 0 |

Strike N. 62° W., dip 6° E.

48. Leasing unit No. 10; West Fork of Paranton Creek, altitude 4,200 feet.

| | ft. | in. |
|--|-----|-----|
| Intrusive rock (diabase) | | |
| Shale roof | 1 | 0 |
| Coal | 6 | 0 |
| Diabase sill | 6 | 0 |
| Shale | 3 | 0 |
| Coal with much shale | 1 | 0 |
| Shale | 1 | 0 |
| Very carbonaceous shale and coal | 6 | 0 |
| Shale | | |

Strike N. 88° E., dip 13° E.

49. Leasing unit No. 10; West Fork of Paranton Creek, altitude 4,100 feet.

Apparently two beds of coal, each 5 1/2 or 6 feet thick, 2 or 3 feet apart, but more probably one bed repeated by surface dipping.
Strike N. 65° W., dip 30° SW.

¹ Included in sample.

50. Lensing unit No. 10; West Fork of Purinton Creek, altitude 3,900 feet.

Coal, 10 feet. Neither roof nor floor of this coal bed could be found. The coal is apparently cut off at each end of the exposure, and what appears to be the bedding. This is the exposure which has previously been described¹ as a 35-foot bed of anthracite. It should probably be regarded as a swollen pocket lying in a closely folded overturned syncline and probably cut by a fault. An exposure of shale in the creek 15 or 20 feet below the coal gave three readings on the bedding as follows: Strike N. 72° E., dip 11° NW; strike N. 70° W., dip 1° NE.; strike N. 73° E., dip 21° NW.

51. Lensing unit No. 10; West Fork of Purinton Creek, altitude 3,880 feet.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Shale roof. | | |
| Coal..... | 1 | 0 |
| Shale (some coal)..... | 5 | |
| Coal..... | 3 | 1 |
| Shale..... | 1 | 1 |
| Coal..... | 1 | 3 |
| Shale with some coal..... | 6 | |
| Shale..... | 2 | 3 |
| Shale with some coal..... | 1 | 0 |
| Shale..... | 2 | 4 |
| Coal..... | 1 | 6 |
| Black shale..... | 1 | 4 |
| Gray shale..... | 12 | 4 |
| Shale with some coal..... | 6 | |
| Black shale..... | 1 | 8 |
| Coal..... | 1 | 10 |
| Shale..... | 8 | |
| Coal with a little shale..... | 1 | 4 |
| Gray shale shale floor. | | |

Strike N. 87° W., dip 55° S.

52. Lensing unit No. 10; east bank of East Fork of Purinton Creek, about 670 feet upstream from section 9.

| | Feet |
|-----------------------------------|------|
| Shale and sandstone, much folded. | |
| Coal with some shale..... | 7 1 |
| Covered..... | 6 |
| Coal with some shale..... | 4 1 |
| Shale and sandstone, much folded. | |

53. Lensing unit No. 10; East Fork of Purinton Creek, altitude 3,480 to 3,550 feet.

| | Ft. | In. |
|--------------------------------|-----|-----|
| Dibase | | |
| Shale (baked)..... | 12 | 0 |
| Sandstone..... | 10 | 0 |
| Shale, with coal blossoms..... | 47 | 0 |
| Coal..... | 2 | 7 |
| Shale floor. | | |

Strike N. 80° W., dip 56° S.

The section given below was measured by Martin² in 1906 on the east fork of

Purinton Creek or on the next creek east of it, on the south slope of Anthracite Ridge.

| | Feet. |
|-----------------------|-------|
| Fluffy sandstone..... | |
| Coal and shale..... | 3 |
| Coal..... | 7 |
| Shale..... | 4 |
| Coal..... | 1 |
| Shale..... | 3 |
| Coal..... | 2 |
| Shale..... | 2 |
| Coal..... | 7 |

Strike N. 89° E., dip 55° SE.

54. Creek bed 1.3 miles S. 24° E. from 6,280-foot peak at head of Purinton Creek, altitude 3,850 to 3,950 feet.

| | Ft. | In. |
|-----------------------------------|-----|-----|
| Dibase sill..... | 19 | 0 |
| Shale..... | 4 | 0 |
| Coal..... | 1 | 1 |
| Partly shale, partly covered..... | 21 | 0 |
| Coal..... | 8 | |
| Shale..... | 15 | 0 |
| Coal..... | 10 | |
| Shale with thin sills..... | 23 | 0 |
| Coal..... | 2 | 0 |
| Shale (partly covered)..... | 27 | 0 |

Strike N. 86° E., dip 44° N.

55. Lensing unit No. 18; creek bed 2.0 miles S. 55° E. from 6,280-foot peak at head of Purinton Creek, altitude 3,850 to 3,895 feet.

| | Ft. | In. |
|-------------------------------|-----|-----|
| Shale with coal blossoms..... | 50 | 0 |
| Coal..... | 3 | 5 |
| Shale..... | 24 | 0 |
| Coal..... | 2 | 2 |
| Shale..... | 21 | 0 |

Strike N. 82° W., dip 20° N.

56. Lensing unit No. 18; creek bed 2.9 miles S. 51° E. from 6,280-foot peak at head of Purinton Creek, altitude 3,830 to 3,850 feet.

| | Ft. | In. |
|--------------|-----|-----|
| Shale roof. | | |
| Coal..... | 1 | 2 |
| Shale..... | 3 | 8 |
| Coal..... | 9 | |
| Shale..... | 2 | 0 |
| Coal..... | 3 | 2 |
| Shale..... | 1 | 1 |
| Coal..... | 7 | |
| Shale floor. | | |

Strike N. 82° W., dip 20° N.

The two following sections described by Paige and Knopf³ were measured by Knopf on either this creek or the next one east of it:

Section of coal on Anthracite Ridge, altitude 3,100 feet.

| | Ft. | In. |
|--------------------------|------|-----|
| Dibase..... | 50 ± | 0 |
| Sandstone and shale..... | 10 ± | 0 |
| Coal and shale..... | 6 | 0 |

¹ Martin, G. C., A reconnaissance of the Matanuska coal field, Alaska, in 1905: U. S. Geol. Survey Bull. 289, 1906, p. 19.

² Martin, G. C., A reconnaissance of the Matanuska coal field, Alaska, in 1905: U. S. Geol. Survey Bull. 289, p. 19, 1906.

³ Paige, Whitney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: U. S. Geol. Survey Bull. 327, pp. 55-56, 1907.

| | ft. | in. | | ft. | in. |
|--|-----|-----|--|-----|-----|
| Coal..... | 2 | 0 | Sandstone..... | 1 | 0 |
| Shale..... | 1 | 0 | Shale..... | 7 | 0 |
| Coal..... | 10 | 0 | Coal..... | 1 | 7 |
| Shale..... | 2 | 0 | Shale parting..... | | 2 |
| Sandstone..... | 7 | 0 | Coal..... | 1 | 10 |
| Strike N. 70° W. (magnetic), dip 10° S. | | | Shale..... | 8 | 0 |
| <i>Section of coal on Anthracite Ridge, altitude 3,600 feet.</i> | | | Sandstone..... | | 0 |
| Sandstone..... | ft. | in. | Shale..... | 3 | 0 |
| Coal..... | 2 | 6 | Coal..... | 1 | 1 |
| Coal and shale..... | 4 | 0 | Shale..... | 6 | 0 |
| Coal..... | 6 | 2 | Coal..... | 1 | 7 |
| Coal and ferruginous clay..... | 2 | 0 | Covered. | | |
| Coal..... | 10 | 0 | Strike N. 66° E., dip 15° S. | | |
| Shale..... | 6 | 1 | 59. Leasing unit No. 18; bed of Muddy Creek, altitude 3,340 to 3,415 feet. | | |
| Coal..... | 12 | 0 | Feet. | | |
| Shale..... | 1 | 3 | Diabase sill..... 100 | | |
| Shale..... | 5 | 0 | Carbonaceous shale containing 6 to 12 coal seams running in thickness from 1 inch to 18 inches. Badly crushed and shivered. | | |
| Sandstone..... | 1 | 0 | Sandstone, thin bedded, and shale.. 28 | | |
| Shale..... | 4 | 6 | Strike N. 8° E., dip 24° W. | | |
| Clay ironstone nodules..... | 6 | 0 | 60. Leasing unit No. 18; crest of spur between Muddy Creek and Packaddle Gulch, altitude 4,400 feet. | | |
| Shale..... | 1 | 6 | Covered. | | |
| Clay ironstone nodules..... | 6 | 0 | Coal..... 11 1/2 | | |
| Highly carbonaceous shale..... | 5 | 0 | Covered. | | |
| Coal..... | 1 | 5 | Strike approximately east, dip 90° E. | | |
| Shale..... | 0 | 0 | 61. North bank of Matanuska River, half a mile above Gravel Creek. | | |
| Sandstone..... | 4 | 0 | Fossiliferous shale..... ft. in. | | |
| Shale..... | 15 | 0 | Coal, clean..... 1 4 | | |
| Coal..... | 10 | 0 | Coal, somewhat shaly..... 9 | | |
| Shale..... | 4 | 0 | Fossiliferous shale..... | | |
| Coal..... | 2 | 2 | Strike N. 10° E., dip 30° NW. | | |
| Shale..... | 4 | 0 | The entire exposure at this point consists of about 200 feet of shale and sandstone, with several carbonaceous zones 10 to 10 feet thick, in some of which there are coal beds several inches thick. The coal bed described above is near the base of the section and extends along the face of the bluff for a considerable distance, in which it shows no indication of lenticularity. | | |
| Shale footwall..... | 10 | 0 | 62. Leasing unit No. 10; gulch 0.3 mile west of O'Brien Creek, altitude 1,800 feet. | | |
| Strike N. 80° E. (magnetic), dip 34° S. | | | ft. in. | | |
| 57. Leasing unit No. 18; Muddy Creek, altitude 3,700 feet. West bank of creek. | | | Black shale with some coal..... 14 | | |
| Sandstone..... | ft. | in. | Gray sandy shale..... 8 4 | | |
| Carbonaceous shale, locally coal..... | 20 | 0 | Black shale..... 7 | | |
| Coal..... | 6 | 0 | Coal..... 7 | | |
| Shale..... | 1 | 7 | Gray nodular shale..... 3 3 | | |
| Shale..... | 3 | 0 | Coal..... 2 0 | | |
| Coal..... | 1 | 1 | Gray shale, much stained by iron..... 10 | | |
| Carbonaceous shale..... | 6 | 0 | Coal..... 9 | | |
| Shale, with flattened ironstone nodules..... | 3 | 0 | Shale..... 2 | | |
| Coal..... | 1 | 2 | Coal..... 4 | | |
| Shale..... | 10 | 0 | Shale with a little coal..... 2 0 | | |
| Ferruginous sandstone..... | 1 | 2 | Ironstone band..... 0 | | |
| Drab shale..... | 1 | 7 | | | |
| Carbonaceous shale, locally coal..... | 1 | 0 | | | |
| Coal..... | 4 | 0 | | | |
| Carbonaceous shale, locally coal..... | 6 | 0 | | | |
| Shale floor..... | | | | | |
| Strike N. 32° W., dip 45° W. | | | | | |
| 58. Leasing unit No. 18; east bank of Muddy Creek, altitude 3,500 feet. | | | | | |
| Shale roof..... | ft. | in. | | | |
| Coal..... | 1 | 2 | | | |
| Shale..... | 6 | 0 | | | |

| | | | | | |
|--|-----|-----|---|-----|-----|
| Coal | Fl. | In. | Gray shale | Fl. | In. |
| Gray nodular shale | 3 | 0 | Gray shale with ironstone con- | 31 | 0 |
| Coal | | 9 | cretions | 3 | 0 |
| Shale | | 2 | Sandstone with some inter- | | |
| Coal | 1 | 3 | bedded shale | 14 | 10 |
| Concealed | 8 | 0 | Shale, somewhat sandy | 15 | 0 |
| Coal and some shale | 6 | 0 | Strike N. 70° W., dip 87° SW. | | |
| Concealed | | | | | |
| Strike N. 78° E., dip 10° E. | | | 64. Leasing unit No. 17; O'Brien Creek about 100 yards farther upstream. | | |
| 63. Leasing unit No. 16; O'Brien Creek, altitude 1,600 feet. | | | Coal with many thin partings, 25 feet. This bed is apparently below the one described above. | | |
| Gray shale under clay | 11 | 0 | 65. Leasing unit No. 16; near top of west bank of O'Brien Creek a short distance above No. 80. | | |
| Coal | | 1 | Large coal outcrop which apparently consists of the bed represented in section 20 folded back upon itself in an overturned syncline | | |
| Shale | | 1 | | | |
| Coal | 1 | 1 | | | |
| Shale with some coal | 1 | 9 | | | |
| Coal | 1 | 0 | | | |
| Coaly shale | | 10 | | | |
| Coal | 2 | 0 | | | |
| Shale with ironstone concretions | 6 | 0 | | | |
| Shale and coal | 4 | 7 | | | |
| Coal | | 2 | 66. Leasing unit No. 17; gulch one-third mile east of O'Brien Creek, altitude 1,800 feet. | | |
| Shale | | 1 | Shale roof. | Fl. | In. |
| Coal | 1 | 5 | Coal | 3 | 9 |
| Shale | | 2 | Coal and some shale | 2 | 0 |
| Coal | 11 | | Concealed | | |
| Shale | | 1 | Rocks dipping gently northeast. | | |
| Coal | | 1 | | | |
| Shale | | 2 | | | |
| Coal | 2 | 0 | 67. Leasing unit No. 17; gulch one-third mile east of O'Brien Creek, altitude 1,800 feet. | | |
| Coal and shale (squeezed) | 1 | 0 | Sandy gray shale roof | Fl. | In. |
| Coal | 2 | 8 | Coal | | 8 |
| Coal and shale | | 9 | Shale with some coal | 2 | 0 |
| Shale | 1 | 2 | Sandy shale. | | |
| Coal | 1 | 3 | Concealed. | | |
| Coaly shale | | 10 | Rocks dipping about 20° NE. | | |
| Gray shale with ironstone con- | | | | | |
| cretions | 13 | 0 | | | |

AREA OF LEASING UNITS.

The approximate area, in acres, of the leasing units in the Matanuska coal field is shown by the table below.

Area of leasing units in Matanuska field.

| No. | Acres. | No. | Acres. | No. | Acres. |
|-----|--------|-----|--------|-----|--------|
| 1 | 390 | 8 | 1,050 | 15 | 710 |
| 2 | 161 | 9 | 800 | 16 | 180 |
| 3 | 930 | 10 | 800 | 17 | 480 |
| 4 | 1,290 | 11 | 610 | 18 | 500 |
| 5 | 1,100 | 12 | 190 | 19 | 610 |
| 6 | 1,050 | 13 | 870 | | |
| 7 | 600 | 14 | 720 | | |

DESCRIPTION OF LEASING UNITS.

The public land survey necessarily included certain areas that were noncoal bearing, and in consequence were not divided into leasing units. In other parts of the field the rocks have not been correlated and in others the cover is great and the position of the coal-bearing

horizon uncertain. These areas, although covered by the public-land survey and shown in the map, have not been arranged in leasing units, as such arrangement is impossible until further data have been obtained on these parts of the field.

Unit No. 1. This unit lies in Moose Creek Valley, between 2 and 3 miles from Matanuska River. Several thin coal beds dipping about 45° northwest are exposed. A measurement of one of these beds was taken at point 41 on the north boundary of the unit (see map of Matanuska field, in pocket), and is given in the list of coal sections on pages 70 to 81. If coal of workable thickness is found, it will probably be opened first by drifts and later by shafts, as the amount of coal above the drift level is small. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad passes through the unit.

Unit No. 2. This unit is located in Moose Creek Valley, about 3 miles from Matanuska River, and contains the best showing of coal so far discovered in the Moose Creek district. There are two or more beds of workable thickness, with fairly good walls, and outcrops that indicate that a reasonably high percentage of lump coal can be produced. The beds dip about 45° northwest and presumably will first be opened by drifts. They were measured at points 40, 41, 42, 43, and 44, and samples were taken at points 40 and 43. (See map.) The measurements are given in the list of coal sections on pages 70 to 81 and the analyses of the samples in the table on page 69. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad passes through the unit.

Unit No. 3. This unit is in Moose Creek Valley, lying mainly south and east of the creek and about 5 miles up the creek from Matanuska River. The coal beds which have been found in unit No. 2 probably extend into this unit. The coal apparently can best be worked through and in combination with unit No. 2, although a crosscut tunnel from the south will be possible. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad crosses the northwestern part of the unit. The route of the suggested spur up Eska Creek from the Matanuska branch terminates a short distance east of the southeast corner.

Unit No. 4. This unit extends from Moose Creek and Wishbone Hill southward. A heavy conglomerate covers the unit and the value of the underlying coal remains to be determined. A bed was, however, measured at point 39 which was inadvertently omitted from the map, on the east bank of Moose Creek in the SE. $\frac{1}{4}$ of SE. $\frac{1}{4}$ sec. 14. The measurement is given in the list of coal sections on page 70 to 81. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad crosses the northern part and the route of the suggested Eska Creek spur crosses the southeastern corner.

Unit No. 5. This unit occupies the summit and slopes of Wishbone Hill and extends southward a distance of a mile and a half. A heavy conglomerate covers the unit and the value of the underlying coal remains to be determined. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad crosses the northern margin of the unit. The route of the suggested Eska Creek spur crosses the southern boundary.

Unit No. 6. This unit lies between Moose and Eska Creeks, mainly east of Wishbone Hill. A heavy conglomerate covers the

unit and the value of the underlying coal remains to be determined. The route of the suggested spur up Moose Creek from the Matanuska branch of the Government railroad passes not far from the northwest corner. The route of the suggested Eska Creek spur crosses the southern end of the unit.

Unit No. 7. This unit lies on Eska Creek, about 3 miles north of Matanuska River and $1\frac{1}{2}$ miles east of Wishbone Hill. A number of coal beds outcrop in the unit, but none is very thick, the average being about 3 feet. The quality of the coal is fair and a good percentage of lump is probably obtainable. The beds were measured at points 28 to 37, inclusive, and samples were taken at points 28 and 30. (See map.) The measurements are given in the list of coal sections on pages 70 to 81 and the analyses of the samples in the table on page 69. The structure is synclinal and the coal can possibly be worked to the bottom of the basin. It may be necessary to start shafts or slopes early in mining operations, as there is not much coal above the drift level. The route of the suggested spur up Eska Creek from the Matanuska branch of the Government railroad terminates at the eastern boundary.

Unit No. 8. This unit lies in Kings River Valley, mainly east of the river, about 7 miles upstream from Matanuska River. The coal exposed dips northeast and will doubtless be opened by crosscuts or drifts starting near Kings River. Sample 25 was taken from the western part of the unit. (See map.) The analysis is given in the table on page 69. Four other sections were measured in the unit at points 21 to 24, inclusive (see map), and these, with No. 25, will be found in the list of coal sections on pages 70 to 81. The route of the suggested spur up Kings River from the Matanuska branch of the Government railroad terminates in the western part of the unit. The route of another suggested spur leaving the Matanuska branch east of Kings River passes about one-half mile south of the southeast corner. The unit has been reserved for Government use.

Unit No. 9. This unit is located south of Castle Mountain, about 14 miles east of Kings River and about 2 miles north of Matanuska River. Little is known concerning the occurrence of coal. It can perhaps be most advantageously operated in conjunction with unit No. 8, the coal being taken out across the latter unit to the suggested spur up Kings River, although the route of the suggested spur leaving the Matanuska branch east of Kings River passes within a short distance of the southeast corner. The unit has been reserved for Government use.

Unit No. 10. This unit lies between Kings River and Chickaloon River, less than a mile west of the latter stream and about $1\frac{1}{2}$ miles north of Matanuska River. The coal beds which outcrop on Kings and Chickaloon Rivers probably extend through the unit. The beds can be opened by slopes. The route of the suggested spur, leaving the Matanuska branch of the Government railroad east of Kings River and following the chain of lakes northeast, crosses the southern margin of the unit.

Units Nos. 11 and 12. These units are located in Chickaloon River Valley, mainly north and west of the stream and less than a mile from Matanuska River. A number of coal beds outcrop along Chickaloon River in these units and constitute the best coal showings so far discovered in the Matanuska field. Some of the coal is

crushed and folded, and in places intruded by igneous rocks, but chemically it is the best yet found in the district. The beds dip steeply - almost vertically - to the north, but the dip probably flattens westward. The beds will presumably be opened by slopes on the coal, though a careful preliminary examination should be made before permanent operations are started. Roof and floor, as shown by the drifts and tunnels at Chickaloon, will require considerable timbering. From these openings a party obtained in 1911 about 500 tons of coal for the United States Navy. The beds were measured at points 8 to 20, inclusive, in unit No. 12. (See map.) These measurements are given in the list of coal sections on pages 70 to 81. Two samples were taken at point 12, and the analyses are given as 12a and 12b in the table on page 69. The survey for the Matanuska branch of the Government railroad extends through the northern part of unit No. 11 and terminates in unit No. 12, giving both units excellent transportation facilities. The two units could advantageously be operated together, though either might well be operated separately.

Unit No. 13. This unit extends from Coal Creek west to Carbon Creek. The northern boundary lies within a short distance of Matanuska River. A number of coal beds are exposed on Coal Creek, just east of the unit, and these beds probably extend through the unit, although they have not been found on Carbon Creek. The unit is easy of access either from Coal Creek, Carbon Creek, or Matanuska River. The route of the suggested spur up Coal Creek passes near the eastern boundary of the unit.

Unit No. 14. The northern boundary of this unit is formed by Matanuska River. Coal Creek flows through the western part. A number of coal beds have been exposed, and it is probable that they can be worked to the bottom of the basin. The beds were measured at points 2 to 6, inclusive, along Coal Creek and the measurements are given in the list of coal sections on pages 70 to 81. At points 2 and 3 samples were taken, analyses of which are given in the table on page 69. The unit is crossed by the route of the suggested spur up Coal Creek and the suggested line along the south bank of the Matanuska River. The unit has been reserved for Government use.

Unit No. 15. This unit has a front of 14 miles on Matanuska River and extends south of the river about a mile. A synclinal basin of coal-bearing rocks extends from Coal Creek in unit No. 14 to Matanuska River in unit No. 15. The beds exposed along Coal Creek will be found also in this unit and can probably be worked to the bottom of the basin. A bed was measured and sampled near Matanuska River at point 1. (See map.) The measurement is given in the list of coal sections on pages 70 to 81 and the analysis of the sample in the table on page 69. The route of the suggested railroad along the south bank of Matanuska River follows the north boundary. The unit has been reserved for Government use.

Unit No. 16. This unit extends westward from O'Brien Creek to the drainage basin of Monument Creek. The northwest corner is near the south bank of Matanuska River. There are several beds of coal, and a maximum thickness of 25 feet was observed. The general dip is to the north, but the dip varies greatly within short distances. Coal beds were measured at points 62 and 63. (See map.) The measurements are given in the list of coal sections on

pages 70 to 81. The coal may be opened by slopes and carried by tramway to the river flat, or the beds may be tapped by cross-cut tunnel from the Matanuska side. The route of a suggested spur along the south bank of Matanuska River lies just outside the northern boundary of the unit.

Unit No. 17.—This unit extends eastward from O'Brien Creek and its northeastern boundary fronts on Matanuska River. Several beds of coal outcrop within the unit, some showing thicknesses as great as 25 feet where observed. The dip, which varies greatly within short distances, is to the north. Coal beds were measured at points 64, 66, and 67. (See map.) The measurements are given in the list of coal sections on pages 70 to 81. The coal may be opened by slopes or may be tapped by tunnels from the Matanuska side of the basin. The route of a suggested spur along the south bank of Matanuska River terminates a short distance north of the northwest corner of the unit.

Unit No. 18.—This unit is on the southern slope of Anthracite Ridge. Although some excellent coal beds are exposed, it is doubtful, because of remoteness, whether they will be commercially available for some time. The beds dip to the north. Roof and floor are good, but the coal is friable, and probably will not produce a large percentage of lump. Coal beds were measured at points 55 to 60, inclusive. (See map.) The measurements are given in the list of coal sections on pages 70 to 81. Presumably the unit when developed will be opened by slopes in the coal, and the product transported by tramway or switchback to the suggested line up Matanuska River.

Unit No. 19.—This unit is on the headwaters of Purinton Creek, on the south slope of Anthracite Ridge. The area has been invaded by igneous masses and only one coal bed seems to be of commercial value. This bed dips south. The roof and floor are fairly good, but the coal is friable and will probably not produce a large percentage of lump. Coal beds were measured in the unit at points 48 to 53, inclusive, and at point 54 just outside the eastern boundary. (See map.) These measurements are given in the list of coal sections on pages 70 to 81. The beds can be opened by slope and the coal transported by tramway or switchback to the suggested railroad along Matanuska River.

METHOD OF DEVELOPING COAL MINES IN THE BERING RIVER AND MATANUSKA FIELDS.

In the Bering River and Matanuska coal fields the geologic conditions resemble those of the coal fields in the State of Washington rather than those of any other district in the United States. There are numerous beds of coal, but the beds have been folded, compressed, and in places faulted. The enclosing rocks are generally sandstones or sandy shales. Early development will probably be by drifts or slopes run from the outcrops of the beds. Afterwards these would naturally be supplemented by level tunnels driven across the strata to strike the different coal beds in which levels could be run. The main openings as a rule will probably be near water level in the valleys, and as many of the intervening ridges are mountainous, the coal mined for some years, at places for many years, will lie above water level. Persons who contemplate opening mines in the bituminous

fields will find it advantageous to study and investigate the methods used in opening and operating the Washington coal mines. One of the difficulties that may be found in some of the leasing units is the mining of a bed in which the coal is so crushed that large pillars will have to be laid out in the advance work or first mining, and the dip side of the pillars may have to be carefully lagged and timbered.

In some places where sharp sands are available, methods of sand filling to replace the coal taken out can be used to best advantage. Such methods are extensively employed in the Pennsylvania anthracite field and in Europe. Although the use of sand filling increases the immediate cost of mining the coal, yet in the long run some of this first cost is recovered through avoiding the crushing and running of pillars and by the prevention of mine fires and explosions, such advantages having been found from experience with this method in Pennsylvania and abroad.

Coal as mined is often more or less mixed with slate, bone, and pyrite, and as transportation charges on Alaskan coal shipped to a distance will be heavy, it will be wise policy to plan for a careful cleaning of the coal by the use of picking tables, slate separators, and washeries. Probably it will prove of advantage to establish washeries under individual or joint ownership, either at the mine or at central points, such as railroad junctions, where plenty of water is available, so that screenings gathered from groups of mines may be conveniently handled and cleaned. Also it may be found advisable to briquet some of the screenings, washed or unwashed according to their purity, possibly using for a binder some of the high-carbon residues from petroleum distillation brought to Alaska on return voyages of the colliers. Briquets of clean coal are often superior for use to the lump coal, and such briquets would undoubtedly be in demand in the Alaskan markets and elsewhere on the Pacific coast.

Some of the washed screenings should be made into coke. Whether it would be advantageous to place coke ovens at the mines or junction points or in the vicinity of the prospective smelters is a question that would require careful study. Where there was a chance of the by-products being utilized, it undoubtedly would be advisable to erect by-product ovens. The tar recovered would be useful as binding material for briquets, the creosote for preserving railroad ties and bridge and mine timber, the benzene for internal-combustion engines, the gas for local power use, and the ammonia and sulphuric acid for transport to Pacific coast ports.